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Technology Review

EDITED AT THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY OCTOBER 1983 $3.00

"Even if the fusion program produces a reactor, no one will want it."

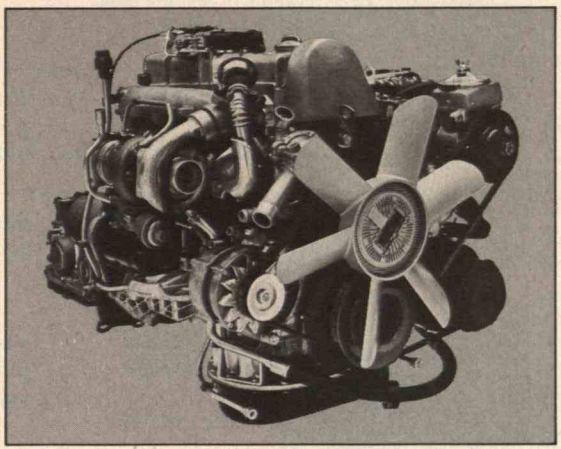
technology
review
Published by MIT

The most successful engine transplant in automotive history.

Mercedes-Benz transferred the best-performing engine in diesel annals from the record books to the production line–creating the best-performing diesel automobile in America, if not the world: the swift, smooth, highly civilized 300D Turbodiesel Sedan.

Five cylinders, turbocharged, so intent on high performance that its pistons would be constantly cooled by automatic injections of oil–it was a radical new breed of diesel engine that Mercedes-Benz designed.

But instead of rushing it into production, the engineers first raced it around the high-speed Nardò circuit in Italy–mounted in the C-111/3 research vehicle shown in the background at left.



Powerful 3-liter, 5-cylinder turbodiesel engine lends the 300D unrivaled performance.

Circulating for 12 continuous hours at an *average* of 195 mph, the C-111/3 and its amazing new power plant proceeded to establish nine new world speed and endurance records. No diesel had ever gone this far, this fast before. And perhaps no record-setter had ever run so frugally before. The C-111/3's fuel mileage for 12 hours at almost 200 mph: 14.7 mpg.

The point had been made. The performance diesel engine was proven. Sufficiently so that its design was then carried over to the production line virtually intact. And is now found beneath the hood of the 300D Turbodiesel Sedan shown here.

The result is the best-performing production diesel automobile in America, if not the world. Generating vivid acceleration and muscular passing power; cruising ease all but indistinguishable from gasoline-powered cars; and EPA fuel mileage figures of 27 mpg city est. and 33 hwy.*

Chassis to match

The 300D's engine performance is complemented by its over-the-road performance.

"The 300D's success in striking a balance between ride, comfort and handling response is equaled by less than a handful of other cars in the world," reports one American automotive journal.

That highlights one key difference between the 300D and common luxury sedans. Another is driving pleasure; this must be one of the *nimblest* 1½-ton automobiles afoot. Its highly refined fully independent suspension system means that you can cover ground quickly in this car–even if the ground is full of chuckholes, sudden curves, or other rude surprises.

The cabin meanwhile affords civilized comfort for five persons. This is more than a matter of trappings and gadgetry. The 300D is a *solid* machine, secure-feeling even in extremes. Careful aerodynamic detailing of the exterior helps keep it almost eerily free of wind noise. Your body is rested in carefully contoured, heavily padded seats specifically designed to cope with the physical stress of prolonged driving.

Amenities are plentiful. Automatic climate control, electronic AM/FM stereo radio and cassette player, electric window lifts–few if any reasonable creature comforts are *not* fitted as standard.

The 300D incorporates 120 safety features as standard equipment as well.

Proven on paper and on the road

Proof of the 300D's worth can be found on any road in America. It is amplified on paper–in the record that this car has compiled for retaining its value.

After the first three years, in fact, the 300D Turbodiesel Sedan has been shown to retain an average of 80 percent of original value, at retail. Proof, indeed.

*EPA estimate for comparison purposes. The mileage you get may vary with trip length, speed and weather. Actual highway mileage will probably be less.

Engineered like no other car in the world

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TechnologyReview

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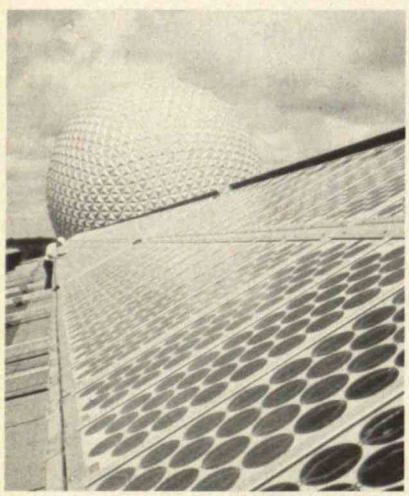

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☐ Other _____

TRO

How Exxon has pioneered systems to optimize

Roy Lieber works at the leading edge of process control.

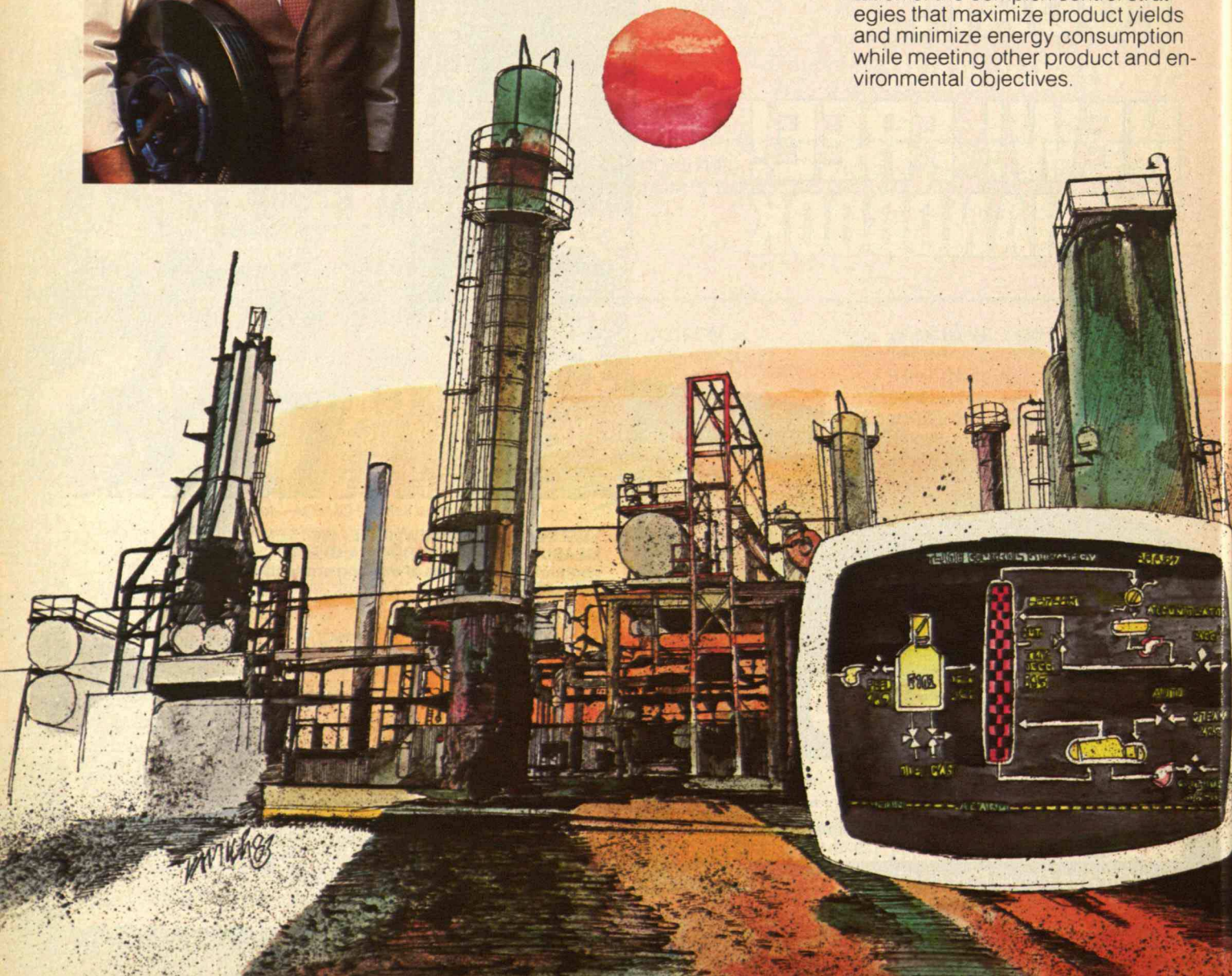
As an operator at an Exxon refinery monitors the schematic of a process on the CRT, the representation of the furnace suddenly changes color and begins to pulse, indicating a condition requiring attention. He touches the screen and corrective action is taken. Elsewhere another operator advises the system by CRT to switch a tower's emphasis from propane to butane as a result of analysis of market data.

Such advanced process control is the result of a long history of pioneering in the application of computers to refinery operation. It goes back to the early 1960's when Roy Lieber and his colleagues at Exxon Research and Engineering Company (ER&E) introduced the use of computers for closed loop control. These first systems, which used the primitive minicomputers of that era, provided superior regulatory control despite their limited functionality.

Precision refining

As computer technology advanced, the systems designed by ER&E became progressively more sophisticated. Combining control theory with process know-how further expanded applications, including the automation of related refinery functions such as blending, product storage and shipping.

Current systems permit implementation of the complex control strategies that maximize product yields and minimize energy consumption while meeting other product and environmental objectives.



advanced computer refinery operation.

User friendliness is also being stressed. Through an interconnected, hierarchical network of micro, mini and maxi computers, today's operators monitor the entire refinery from work stations housing three to five CRTs.

Future trends

Exxon has installed more than 100 closed loop computer control systems in its refineries and chemical plants worldwide. In fact, the majority of these plants are totally under computer control.

Advanced as the computerized process control systems are today, Roy Lieber feels there is still great potential for future economies and efficiencies. He talks about work on integrated networks of systems sharing data on all aspects of refinery operation both within and between plants. Using advances in electronics and concepts such as artificial intelligence, the goal is to optimize single refineries and conceivably even refineries on a regional and a worldwide basis. He is helping guide the development of the hardware and software that will make this possible.

Exxon Research and Engineering Company

Process control technology is but one example of the numerous activities underway at Exxon Research and Engineering Company. A wholly owned subsidiary of Exxon Corporation, ER&E employs more than 2,000 scientists and engineers working on petroleum products and processing, synthetic fuels, pioneering science and the engineering required to develop and apply new technologies in the manufacture of fuels and other products. For more information on process control or ER&E, write Dr. E.E. David, Jr., President, Exxon Research and Engineering Company, Room 707, P.O. Box 101, Florham Park, N.J. 07932.

EXXON

SCIENCE/SCOPE

A Very High Speed Integrated Circuit chip has been produced at Hughes Aircraft Company, marking a significant step toward using advanced semiconductor technology in military systems. The chip, built after less than two years of development, contains 72,000 transistors in an area the size of a thumb tack. The VHSIC program is being conducted by the U.S. Department of Defense to develop chips that will give military electronic systems a tenfold increase in signal processing capability. The high-speed, compact VHSIC chips will be more reliable and will require less power than integrated circuits now in use.

A new video graphics projector that's brighter and sharper than conventional projection TV may be the next addition to office computer systems. The Hughes projector displays monochromatic computer-generated alphanumerics, symbols, and graphics. It could be used for displaying dynamic computer data and facsimile video pictures in board rooms and other areas, and for teleconferencing. The projector uses a device called a liquid-crystal light valve, a cousin of displays in digital watches. This device intensifies the image from a cathode-ray tube and projects it onto a screen up to 12 feet wide. The picture is so bright and has such high resolution that the viewing room needn't be darkened.

A uniquely shaped waveguide antenna is one of 13 patentable innovations built into the Advanced Medium-Range Air-to-Air Missile. The antenna is configured to occupy a very small space and yet provide a low-frequency-band data link to launching aircraft. Its novel shape also minimizes interference and provides a moderate amount of cross-polarization, a feature that improves communications. Hughes designed and developed AMRAAM for the U.S. Air Force and Navy.

The U.S. Navy's A-6E Intruder aircraft will carry an improved turret for its electro-optical system, which lets the aircrew see and attack surface targets shrouded by darkness, smoke, or haze. The turret, located on the aircraft's chin, is part of a combination laser and infrared device, the Hughes Detecting and Ranging Set. While the original turret allows access from the bottom, the new clamshell-like design allows quick access from both top and bottom to simplify maintenance. The design also reduces the length of flat cable in the turret by 35 feet. The new turret will be introduced in December.

"Diversification" characterizes Hughes Industrial Electronics Group, located in the Southern California communities of Carlsbad, Irvine, Newport Beach, Sylmar, and Torrance. Our facilities are like small companies with 500 to 2,500 employees, but each offers the resources and benefits of a multibillion-dollar company. Our diverse technologies include silicon and GaAs semiconductors, fiber optics, microwave and millimeter-wave communications, microprocessors, lasers, and solar cells. Send your resume to B.E. Price, Hughes Industrial Electronics Group, Dept. SE, P.O. Box 2999, Torrance, CA 90509. Equal opportunity employer.

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LETTERS

Trusting U.S.A. Inc.

To try to disprove the idea that the Japanese government controls Japanese industrial development is disproving something which doesn't exist. "To Trust or Antitrust" (*by Richard Corrigan, July, page 49*) points to the cooperative rather than directive approach used by the Japanese government. In contrast, the relationship among government, industry, and academia in the United States has been fundamentally adversarial. "The Myth of Japan, Inc." (*by Toshimasa Tsuruta, July, page 42*) serves to ease some apprehensions. America's scientists and engineers should work toward generating a greater degree of cooperation among their own institutions to compete effectively with the Japanese.
David G. Ziegler
Arlington, Va.

Solar Savings

If Mark Hyman (*Solar Home Investment vs. Payback, April, page 55*) wants to give me $6,000 today, I will be happy to return $1,250 a year back to him for the next five years. And he won't have to build another solar house to get it.

The point is, money has a time value and "payback" is a meaningless term used in the solar industry. Discounted cash flow or life cycle costing are the only meaningful investment comparisons, but that would make the future of the solar industry not so bright.
Douglas Ruth
Logan, Oh.

Mr. Hyman responds:
If I were to advance Mr. Ruth $6,000, he would have to pay me back for more than five years since my house is well-built and should last at least fifty years. During this period, my savings would be tax-free. If he paid me, the income would be taxable. If I were in the 40 percent tax bracket (30 percent federal and 10 percent state), he would have to pay me $2,083 per year for me to save $1,250.

However, these figures assume that energy costs will be constant (in terms of current dollars) during the 50-year period. But most students of the energy situation believe that the cost of energy will advance substantially. In a more practical analysis, if I take out a 30-year mortgage of $6,000 at 12.5 percent interest, it will call for a constant payment of about 15 percent for 30 years. Thus, for a net investment of zero, I will pay $900 a year but save $1,250—an annual gain of $350, tax-free. In addition, in the first year of the mortgage I will have a deductible expense of $750 with a tax saving of $300. Hence the gain from a zero investment will be $650. The deductible expense will decrease as the mortgage is paid off, but after 30 years the annual savings will be $1,250. Over the assumed life of the house, the total savings will be $40,000.

Care for Cystic Fibrosis

In "Gene Therapy: Will It Work?" (*April, page 82*), Tabitha Powledge states that treating cystic fibrosis requires constant use of an oxygen tent and special feeding. This is true for only a very small number of patients. In one study of 70 patients above 25 years of age, none required oxygen tents or special feeding. Cystic fibrosis is a very complicated disease, with the severity varying from patients who outwardly appear to be healthy to severely ill patients who are confined to bed.
Harry Shwachman
Boston, Mass.

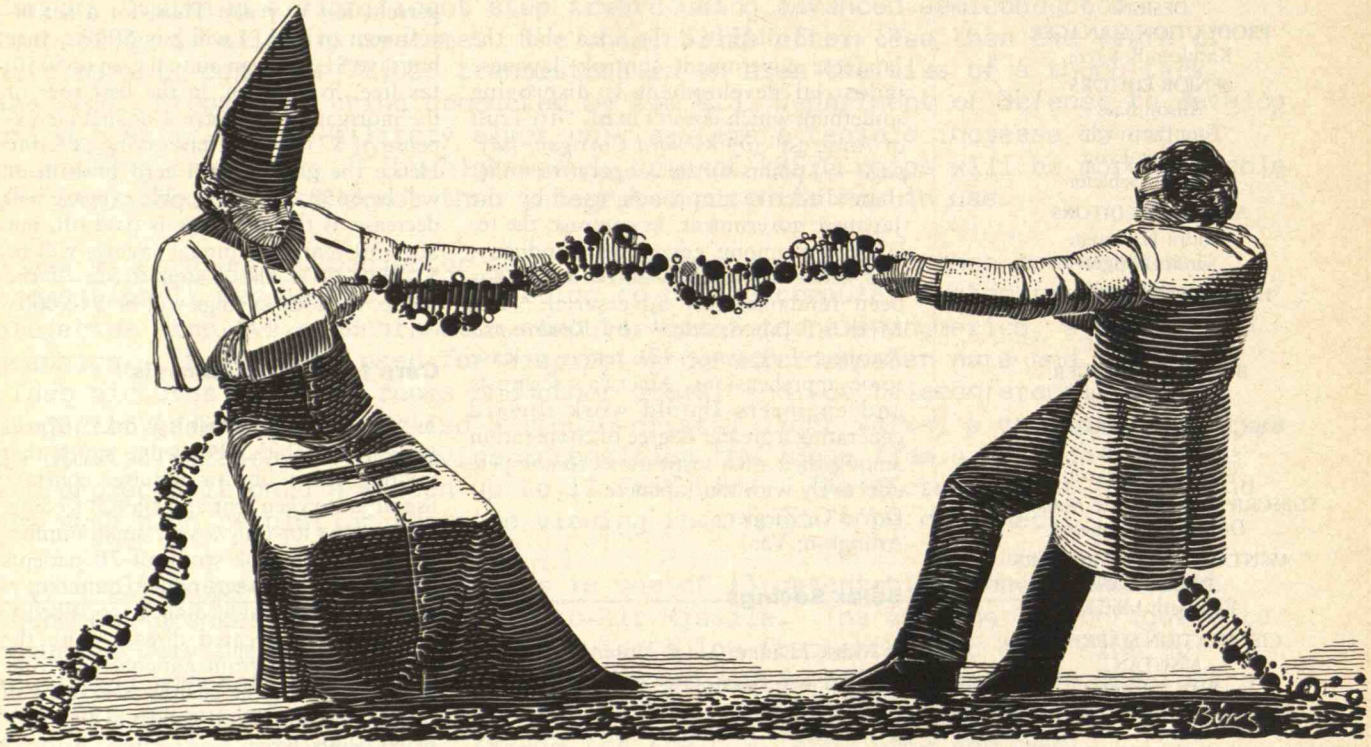
Dr. Shwachman is professor emeritus and consultant on cystic fibrosis at the Children's Hospital Medical Center.

Unity in Diversity

"A United Voice for Engineers" (*by Samuel C. Florman, July, page 8*) identifies problems in the search for unity among engineers. It points to the virtues of a strong single voice for the profession. Engineers' need for unity is exemplified by the hundreds of technical societies which are not formed for the purpose of splintering the engineering profession but to bring together those with common problems—coping with the complexities and advancement of technology. Each technical society is charged with specific goals of advancing the "state of the art" and communicating to its members its place in the broad engineering and technology spectrum. This purpose does not prevent members of technical engineering societies from joining in a common voice in professional activities and cooperative efforts.
John Dicky
North Tonawanda. N.Y.

ROBERT C. COWEN

A Challenge for Genetic Engineering



You don't have to hold a wet finger in the wind of public opinion to sense an undercurrent of concern over genetic engineering. People are worried that people may one day redesign people, yet many genetic scientists still act as though they can ignore public opinion. That is why Reverend John C. Fletcher, bioethics consultant to the National Institutes of Health, told a recent meeting of the Industrial Biotechnology Society that public fears have to be taken seriously even though they may seem to lack a scientific basis. He explained: "The dynamics of genetics were, and are, thought to be—by some—directed by divinity. This belief is very strong. It's still there, and it has to be dealt with."

This is also the essential message of a resolution sent to Congress June 8 by some 64 religious leaders and a few "concerned" scientists. This resolution urged Congress to ban research that could lead to redesigned people, stating that "efforts to engineer specific genetic traits into the germline of the human species should not be attempted." Unfortunately, biotechnologists have tended to react angrily to what looks like an attempt to stifle research, instead of trying to deal thoughtfully with the underlying fear.

ROBERT C. COWEN is science editor of the *Christian Science Monitor* and former president of the National Association of Science Writers.

The appeal to Congress does seem to be ill-considered. After all, in 1980 the National Council of Churches, the Synagogue Council of America, and the U.S. Catholic Conference sent a statement to the White House expressing similar concern. That statement asserted that the questions of whether and how genetic engineering might be applied to humanity "deal with the fundamental human being." President Carter then appointed the President's Commission for the Study of Ethical Problems in Medicine and Biomedical and Behavioral Research. The commission, which reported last November and was dissolved at the end of March, saw no reason to restrict research, at least at this stage. However, it did recommend establishing a permanent body to monitor the progress of genetic engineering and to consider its social and ethical implications, especially regarding humans.

Congress responded favorably. Rep. Albert Gore, Jr. (Democrat of Tennessee) promptly held hearings. He later added an amendment to a reauthorization bill for the National Institutes of Health that would set up a bioethics watchdog commission. This legislation, although still pending, is expected to be enacted. The Senate Committee on Labor and Human Resources has also approved the concept of a watchdog commission.

Thus, the ethical challenge of genetic engineering has hardly been neglected, so the June 8 resolution seems curiously inopportune. Alex Capron, former director of the president's bioethics-commission staff, called it "knuckleheaded"—a "broadside attack" where careful, ongoing consideration of difficult ethical issues is needed.

The resolution's credibility was further eroded when it became known that it was largely the work of Jeremy Rifkin, a well-known activist and director of the Foundation of Economic Trends in Washington. Mr. Rifkin's views on the social impact of science and technology are

ILLUSTRATION: CHRISTOPHER BING

widely considered alarmist and scientifically muddled. His latest book, *Algeny*, is a lengthy treatment of the concerns reflected in the June 8 resolution and a rejection of virtually all genetic-engineering research as too dangerous.

Drawing the Germline

Mr. Rifkin spent a year gathering signatures for the resolution. He also prepared a 10-page memorandum to which he gave the awesome title "Theological Letter Concerning the Moral Arguments Against Genetic Engineering of the Human Germline Cells." There he makes the wild claim: "It will soon be possible to engineer and produce human beings by the same technological design principles as we now employ in our industrial processes." He adds: "Once we decide to begin the process of human genetic engineering, there really is no logical place to stop. If diabetes, sickle-cell anemia, and cancer are to be cured by altering the genetic makeup of an individual, why not proceed to other 'disorders': myopia, color blindness, lefthandedness. Indeed, what is to preclude a society from deciding that a certain skin color is a disorder?" In short, the memorandum urged a halt to research on genetic engineering of humans, even if it might lead to cures of genetically based diseases, on the ground that this opens the way to abuse. The resolution, on the other hand, seemed to leave the door open to research on therapeutic uses if these didn't adversely affect the germline.

Not all signers of the resolution have been willing to support the memorandum. A number, when pressed, say they want research on curing genetic ailments to proceed. Indeed, some seem to have signed the resolution largely to voice concern, not to halt scientific work. For example, *Nature* reported that Father Richard McCormack, S.J., who is with the Kennedy Institute of Ethics at Georgetown University, signed the resolution because he considered it a "good vehicle for public discussion," even though he disagrees with its call for a ban on germline work.

Thus, although many of them agree that serious ethical issues may eventually be involved, geneticists and biotechnologists have difficulty seeing the June 8 resolution as anything more than a needless cry of alarm. They especially feel this way in view of how far they are from any practical techniques for even modestly redesigning human beings.

Research Realities

So far, the scientific basis for inducing inheritable genetic changes in mammals is slim. In a few experiments, mouse eggs have been manipulated shortly after fertilization so that foreign genetic material could be introduced. This material has been inherited by future generations. But such integration of foreign DNA is inefficient and uncertain, as Arno G. Motulsky of the Center for Inherited Diseases at the University of Washington explained in the January 14 issue of *Science*. The experiments, he says, "show that genetic manipulation of germ cells is a distinct possibility," but "much remains to be done" to make it practical. Bernard D. Davis of the Harvard Medical School has asserted that the uncertainty of being able to use such techniques safely—that is, to produce healthy embryos reliably—is so large that it "will deter responsible investigators from altering human embryos for a long time to come."

Thus bioscientists think there is no reason to panic, no rational basis for alarm. But if it is tempting to ridicule Jeremy Rifkin and patronize the anxious religious leaders, that is a temptation to be resisted. Mr. Rifkin's book and resolution may indeed be alarmist and scientifically muddled. But they reflect a concern of the general public that the remote deliberations of a presidential commission and of Congress do not directly address.

There is great need for public education, for continued discussion of the profound questions raised by genetic engineering. Bioscientists should take part in that public discussion, as some did during the past decade when the safety of bioengineering was an issue. Scientists need to talk with fellow citizens as equals—to recognize that their concerns are genuine. This takes patience and professional humility. Reverend Fletcher was right when he said that the public's concern about the implications of genetic engineering "is an honest question, and it deserves an honest answer." Even Mr. Rifkin, with all his reservations about genetic engineering, has said he could support the concept of a watchdog commission (instead of a ban) if its first priority were to open the issues to public discussion in forums across the United States. □

SAMUEL FLORMAN

Profit and Engineering

How does the profit motive relate to the practice of engineering? I asked myself that question during a recent trip to the Soviet Union, that strange and forbidding land where all technological work is performed in the name of the state.

When Lincoln Steffens visited revolutionary Russia in 1919, he was mightily impressed. "I have seen the future," he wrote to a friend, "and it works." Whatever else can be said about the Soviet system today, it does not appear to be working, at least not very well. One can reach this conclusion by reading a massive study recently completed by the Congressional Joint Economic Committee, *Soviet Economy in the 1980s: Problems and Prospects*, or Marshall I. Goldman's *USSR in Crisis: The Failure of an Economic System*. Or, as an ordinary tourist, one can simply observe.

Even in the wealthiest sections of the largest Soviet cities, practically no fruits or vegetables are to be had. There are no cafes or pubs nor any of the colorful window displays that are such a prominent feature of Western cityscapes. There are few cars in the streets and, most telling, hardly any merchandise in the shops. While walking the streets of these grim metropolises, I found it difficult to believe I was actually in one of the world's so-called superpowers.

To be sure, the almost total absence of consumer comforts is partly attributable to policies of the Soviet government, which emphasizes basic heavy industry and armaments. And other factors such as geography, climate, history, psychology, and the like undoubtedly influence the economy. It is obvious, however, that the Soviet industrial system is badly crippled by the lack of economic motivation. When the entrepreneurial spirit cannot be rewarded and nonproductive workers cannot be discharged, stagnation sets in. Everything we know about human nature tells us this must be so. These assumptions are born out by the frustrated statements of Soviet leaders, as well as by the studies of Western experts.

SAMUEL C. FLORMAN, a civil engineer, is author of *Engineering and the Liberal Arts, The Existential Pleasures of Engineering*, and *Blaming Technology*.

No Incentive

Tourists garner additional evidence as they encounter sullen and inattentive workers at every turn. In my own field of building construction, the lethargy is almost palpable. I can spot a sick construction job from a quarter-mile away, and I saw such jobs all over Moscow and Leningrad. Tall cranes tower over sprawling concrete frames, and lost in the immensity of the structure a few workers putter away connecting pipes or laying masonry blocks. Perhaps some critical materials, the door frames or the windows, have not arrived. Or maybe some crucial crew is not available—the electrician, say, or the sheetmetal workers. In capitalist societies, the marketplace would not permit such waste of invested capital. Bankers want their loans repaid and the interest clock runs without stopping. Manufacturers avidly pursue orders and workers seek employment wherever they can find it. Contractors have learned to equate success with timely completion, and they dread the ruin that stalks the dawdler.

In the Soviet Union, buildings not only take too long to build, but many start to fall apart before they are finished. Chipped masonry and cracked concrete are as much a feature of Moscow streets as red-starred wall posters and pictures of Lenin. So widespread are the problems with postwar apartment buildings that even a stubbornly patriotic guide admits, "At first we concentrated on quantity; now we must concentrate on quality." But if nobody gains when quality is good, and nobody loses when it is bad, it is hard to see how such a focus is going to help.

In free-market nations, profit calls the tune. From dishwashers and automobiles to radios and pocket calculators, the products that fill our sparkling stores are created by people thinking of gain. Each consumer's desire—or potential desire—becomes an energizing force. Into every interstice of demand moves a rush of hopeful designers, manufacturers, and salespeople. And whatever products do not sell quickly at retail end up at an auction of remainders. No five-year plan can hope to equal such a sensitive system.

And at the heart of this system—pulsing to the rhythm of profit and loss—is creative engineering. Clever ideas increase earnings. Money-saving procedures are sought out and rewarded. Creativity begets profit, and profit elicits creativity.

Of course, this marvelously efficient system has its social costs. We pay a high price in the form of unemployment, bankruptcies, and anxiety—and engineers bear their full share of these afflictions. The Soviet commitment to equality and full employment, however ineffectual in practice, responds to human cravings for justice and security. Any capitalistic society that does not address such elemental needs cannot be considered satisfactory, no matter how wealthy it may be. There is also a dark side to the profit motive—an unpleasant complication that we ac-

Continued on page 16

ILLUSTRATION: ELIZABETH SLOTE

From left to right:
Dr. C. Denis Mee, IBM Magnetic Recording Institute, San Jose, California.
Dr. Werner Kulcke, IBM Manufacturing Technology Center, Sindelfingen, Germany.
Dr. Alan B. Fowler, IBM Thomas J. Watson Research Center, Yorktown Heights, New York.
Richard C. Chu, IBM Development Laboratory, Poughkeepsie, New York.

These men just got what they deserve.

They have just been named IBM Fellows and for five years they are free to pursue whatever experimental projects they wish.

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The IBM Fellows program is just one way we encourage people who have had great ideas to have more of them.

IBM®

BY GEORGE R. HEATON, JR., AND J. HERBERT HOLLOMON

Diffusing Technical Knowledge: A National Imperative

WITHIN the past few years, the United States has become acutely conscious of its economic vulnerability. Commentators of all political persuasions have pointed to severe problems facing the country: lagging productivity, poor product quality, high unemployment, unfavorable trade balances, loss of traditional markets, and regional imbalances. Many of these commentators see increased technological innovation as a general solution to our national difficulties. This is undoubtedly partly true. Innovation—the first commercial application of a new technical idea—does indeed create new markets, restructure industries, and achieve radical advances in technology. But the focus on innovation can obscure an equally important part of technological development: the widespread adoption and improvement of innovations by those who did not develop them.

Diffusion of technology is a strategy that the United States has undervalued too long. Government policies have allowed massive R&D expenditures to dwarf diffusion-oriented programs. Some of our major industries have ignored important technological developments elsewhere in the world. Small companies have also failed to make use of readily available technical information, limiting their ability to compete with larger firms. U.S. Department of Labor statistics show that during the 1960s, the best firms in various industries were typically about 2.4 times more productive (measured by the value added to products per employee) than the worst firms. More recent data from the 1970s indicate that this gap has widened. If this disparity between the leading and lagging firms were narrowed by more rapid diffusion of state-of-the-art techniques, a dramatic improvement in overall U.S. productivity would occur. While not a route to dramatic breakthroughs, technical diffusion is an important, relatively low-cost way for the United States to improve productivity, stay abreast of international competitors, and reduce the imbalances among different social groups. We must make a major effort to use existing knowledge better.

GEORGE R. HEATON, JR. is principal research associate of the Center for Policy Alternatives at M.I.T. J. HERBERT HOLLOMON, formerly Japan Steel Industry Professor of Technology and Policy at M.I.T., has recently been named a university professor and director of the Center for Technology and Policy at Boston University.

An Educational Process

Strictly speaking, the mere sale of a product is diffusion, but mastery of the underlying technical knowledge—the really important kind of diffusion—will not occur unless the purchaser understands how the technology functions. Of course, technical knowledge is not limited to products and manufacturing processes. Techniques for improving management, quality control, and productivity are also in crucial need of diffusion.

Diffusion is fundamentally an educational process. Indeed, diffusion of knowledge from universities to industry is one important path by which technical advances occur. For instance, the success of Route 128 near Boston as a beltway of technology-based companies is due in no small measure to the transfer of knowledge and people from nearby universities. Similarly, the high mobility of personnel among companies along Route 128 and in California's Silicon Valley has been an extremely important factor helping the diffusion of technology and growth of firms in these areas. It is relatively common for professionals in these companies to leave and set up their own firms, often in direct competition with their previous employer. This pattern of technology spin-offs exists but to a lesser extent in other countries as well. For example, a recent M.I.T. study of entrepreneurship in Sweden indicates that many new Swedish firms are built on the technical knowledge entrepreneurs have gained either in universities or from immediate past employment.

Public Initiatives

Government action can also promote technological diffusion. Although many successful diffusion programs have been undertaken in the United States, they are typically underfunded and do not have the high visibility of large-scale research efforts. One example is the State Technical Services Program (STS). An act of Congress in 1965 established STS, which consists of state-run extension services for industrial technology. Although the act provides no federal funding, about 25 states have set up such programs. In Vermont, for example, the state STS program showed cheese manufacturers how to convert liquid whey into a dried edible product instead of dumping it into rivers.

ILLUSTRATION: JIM CARSON

This not only solved a pressing pollution problem but also added new employment in the state.

STS was modeled after an outstanding example of government-supported diffusion: the U.S. agricultural extension service. Federally funded for more than 100 years, this service employs full-time extension agents who keep abreast of new research developments at universities and bring those developments to farmers. These agents often rely on demonstrations to spread the word. In trying to acquaint farmers with a new seed for corn, for instance, they may ask one farmer to grow that seed on a section of his farm and then invite other farmers in the area to observe the result.

The agricultural extension service is instructive not only because it has been so successful, but also because of the conditions that led to its success. Before the government program began, private interests, principally the railroads, realized they had a stake in improving productivity among their shipping customers, the farmers. The farmers themselves typically lacked the time and resources to upgrade their level of technical expertise, but they were receptive to the need to do so. Consequently, some of the railroad companies made an effort to disseminate information about new agricultural techniques. Later, with government aid, the land-grant colleges attempted to educate farmers in the traditional academic style. When this attempt failed miserably, the idea of government-funded extension agents was born.

Many other government programs indirectly affect technological diffusion. Federal environmental standards are often based on the pollution-control technologies of "leading firms," which are then diffused through the industry by regulation. For example, the effluent standards in the Water Pollution Control Act are based on the "best available" controls already installed by major manufacturing companies.

In another context, federal policymakers were clearly thinking of the need to promote diffusion when tax depreciation practices were changed in 1981. They recognized that much of American plant and equipment was outdated, and that decreasing the effective cost of new investments by a more rapid depreciation scheme would promote modernization.

Technology transfer programs, now required by the 1980 Stevenson-Wydler Act in all large federal R&D institutions, are sometimes seen as an effective way for government to promote diffusion. But these programs usually attempt to effect only the initial commercial use of technical development; they rarely promote applications widely. For example, programs to transfer technology from NASA space missions to the commercial sector are often cited as a model for technological diffusion, but in fact few technologies have been adopted for civilian use, and fewer still have been widely diffused. We believe demonstration projects of the kind so successfully employed by the agricultural extension service more clearly fit the purpose of diffusion, since they attempt to prove and publicize the feasibility of a new idea in a concrete setting. The Steven-Wydler Act, though perhaps a useful first step, would have been more valuable if it had provided for frequent, well-publicized demonstrations instead of the more limited technology-transfer efforts now underway.

Japan: Master of Diffusion

Foreign governments have also been concerned with technological diffusion. Japan is the outstanding example of a country that deliberately encourages the diffusion of technical knowledge from around the world into its industries. In both the public and private sectors, the Japanese expend a great deal of effort simply monitoring technical developments elsewhere and attempting to use them where appropriate. Private-sector "trading companies" play an important part in diffusing technology and other types of expertise into the diverse firms they serve. A large trading company such as Mitsubishi, for instance, might help a small machine-tool company market its product abroad by advising the company which markets to enter and what prices to charge, and by arranging financing through an affiliated bank. Japanese manufacturing companies, in turn, spend a great deal of their resources on worker training, trade and professional organization meetings, and trips abroad. And the government's Ministry of International Trade and Industry (MITI) is an effective collector and communicator of information about domestic and foreign markets and technology.

Most important, the Japanese are quick to adopt new ideas. Two examples illustrate this point. As is well known, many Japanese companies have adopted W. Edwards Deming's methods of management and quality control. These include the use of rigorous analytical practices to improve worker productivity as well as product quality. Deming also emphasizes the need for worker participation in monitoring productivity and improving quality. The Japanese adopted these practices soon after World War II when their products suffered from a reputation for shoddiness. Although one certainly could not attribute the current high standards of Japanese goods entirely to the "Deming way," the diffusion of these techniques was undoubtedly a low-cost, high-payoff strategy for the Japanese.

The Japanese have also managed to diffuse the important new technology of robotics extremely rapidly. From the introduction of the first robot in a Toyota plant in 1967 (almost ten years after a similar event in the United States), the Japanese robot population has grown to about 14,000—more than three times the number in the United States. This diffusion of robots in Japan has significantly enhanced productivity in many industries. Realizing this potential, the government has decreased the cost of installing robots via a special tax depreciation. In addition, labor shortages and the relatively low cost of borrowing money to make capital improvements have augmented the introduction of robots.

The British have also made some interesting initiatives. For example, a network of industrial associations conducts government-subsidized research projects, on the stipulation that the results be made available to all firms in the industry. On occasion, the British government has also encouraged technical diffusion by subsidizing the use of consultants. This practice has been most successful in the semiconductor industry, where government-funded consultants advised individual companies on how to employ new chip technology.

What the U.S. Should Do

Throughout the remainder of this century, an increasing percentage of new technology will be developed outside the United States, and we must learn how to tap this resource. U.S. government agencies should be much better-informed about

developments abroad; translating Japanese technical publications is one way to begin. Another constructive step was the recent enactment of Export Trading Company legislation, which allows banks and other institutions to participate in companies designed to finance and facilitate trade. If the American trading companies work like their Japanese counterparts, they will be a major factor in diffusing foreign technology in the United States.

Increased communication within the country is important as well—among companies in different industries, between industry and universities, and between industry and government. Specifically, firms in a given industry might do well to emulate the British model and undertake more joint technical activities. The Microelectronics and Computer Technology Corp. (MCC), a research consortium of 20 microelectronics companies headquartered in Austin, Tex., is one much-publicized example of this kind of undertaking. The government also needs to decentralize its technical support programs, much as the agricultural extension service did, to reach the small companies and rural schools most in need of technical knowledge. More government money also needs to be spent on this kind of initiative.

The Role of Private Enterprise

Even though government can help it along, diffusion of technology is essentially up to private enterprise. However, few American firms realize and act on the potential of technological diffusion. Most companies need to spend more time and resources on internal communication among employees with overlapping technical interests. In an effort to diffuse information among companies, some leading electronics companies have set up independent research groups for their top scientists. These groups, comprised of personnel from different companies, meet regularly to discuss difficult research problems. Japanese companies are renowned for their emphasis on rotational assignments, in-house training, and international tours of duty for employees.

In the United States, and elsewhere, the "gatekeeper function" is an important mechanism for technological diffusion. In industrial research laboratories, gatekeepers are the people who bring the most information to the lab from the outside world, whether from reading trade journals, attending conferences, or just discussing new developments with other members of the industry "network." Although their job title may range from company president to junior engineer, gatekeepers' function is to transmit new ideas to their colleagues.

Much as gaps in knowledge exist in industry, so too do they exist among classes of society. Rural and inner-city school systems are typically inferior to those in wealthy suburbs. Because of less-than-adequate education, minorities are underrepresented as employees in "high-tech" growth industries. If this disparity continues, the already huge gap between rich and poor, between literate and illiterate, will only grow worse. Better mechanisms for diffusing technical knowledge, not only in industry but in schools as well, are needed to help cure social problems and improve productivity nationwide. Although such improvements may be of small magnitude in individual instances, they will make an enormous difference overall. □

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knowledge in our condemnation of avarice. At what point does wholesome ambition become unwholesome greed?

For Love or Money?

Our uneasiness in the face of this moral issue is especially intense when we contemplate the professions. We recognize that doctors, lawyers, and engineers like to earn a lot of money, but we find this disquieting. Last year there was an article in *IEEE Spectrum* called "How to Make it Big: Engineers as Entrepreneurs." I read it with interest, indeed fascination, but also a feeling of guilt. Every so often a story comes out of Silicon Valley about another engineer who has converted his brilliance into an instant fortune. Yet in some recess of our mind we wonder—is this what engineering is all about?

Even as we ask the question we know the answer. The quest for profit is not the essence of engineering. Indeed, there is ample evidence that most American engineers are motivated by other forces. The field of civil works is populated by thousands of engineers who work for modest salaries and find satisfaction in accomplishment and service. In academia and government, many of our most accomplished engineers seek rewards in research, discovery, and problem solving. Even in the private sector, most engineers do not equate professional fulfillment with monetary gain. Dollar income is one, perhaps important, measure of worth and reward, but not the only one. All engineers enjoy aspects of their work that have precious little to do with money. In fact, few engineers become entrepreneurs, and there is a long history of conflict between the two groups.

Although the accomplishments of free enterprise are dazzling, we would be mistaken to assume that only profit-motivated endeavors will succeed. Around the beginning of this century, there was a movement to put public utilities in the United States into the hands of private enterprise, it being held that governments were by nature ineffectual and corrupt. Yet in the ensuing years, government agencies have successfully undertaken many great works. Few people today suggest that our highway and water systems be turned over to private interests.

With these thoughts in mind, I now see that my initial reaction to the Soviet Union was somewhat simplistic. While it is obvious that consumers are ill-served by the dominance of government, it is equally obvious that there are some things the Soviet government does fairly well. The trains run on time. Subways are a showplace. And clearly there are competent people working in the fields of space and weaponry.

One's view as a tourist is strangely distorted. Although I was taken into ancient monasteries and tsarist palaces, I was not permitted to see factories and shipping centers, not to mention laboratories and space facilities. I learned more about icons than about Soviet technology. I did gain entrance to the Technological Institute in Leningrad, thanks to a sleepy guard at the door, but once I made my presence known to the authorities, I was politely but earnestly urged to leave.

So I gained no special knowledge about what motivates Soviet engineers. From what I have read, the best are granted perquisites that are the equivalent of handsome salaries in other societies. I have met a few Soviet engineers who were traveling on government business, and they seemed cheerful enough, although not about to share their inner thoughts on career satisfaction with Americans. I suppose, like most of us, in addition to material rewards, they strive for honors and reputation. Also, like engineers in all places and at all times, they must be motivated by the pure fascination with the task at hand.

One can even speculate that these engineers' work serves to divert them—to help them forget for a time the harsh realities of living in a totalitarian society. I am reminded of an imprisoned engineer in Aleksandr Solzhenitsyn's novel, *The First Circle*, who becomes totally absorbed in the technical project assigned to him: "This capacity to devote himself wholly to his work, to forget about life, had been the basis of his engineering triumphs on the outside, and in prison it helped him bear his misfortune."

There is a dark fascination in speculating about the Soviet Union, but in the end that enigmatic culture defies the analysis of experts, to say nothing of presumptuous tourists. As for the relationship between engineering and profit, that too resists precise definition. Profit is a spice, a spark, a catalyst—a crucial element of the technology that has flourished in capitalist societies and remade the world. The empty shelves of Soviet stores bear witness to the importance of the freedom to seek personal gain. But the achievements of engineers in socialist societies show that technology comes from creative wellsprings that have nothing to do with profit and recognize no political borders. ☐

FORUM

BY ALISON BASS

Disney and the Corporate Con

NEWLY arrived at Disney World, a mother and her teenage daughter were discussing their plans for the day. The daughter was saying, "I really want to see the Magic Kingdom. Can't we go there?"

"Sure," the mother replied. "But I want to see EPCOT first. That's education."

The problem is that EPCOT—Experimental Prototype Community of Tomorrow—is not education. Nor is it a "proving ground for American technology," or even a very clear view of the future, despite what Disney literature says. EPCOT is corporate America's view of technological progress—a view that is sadly oversimplified and sugarcoated with hype.

In designing EPCOT, Disney executives seem to have buried their founder's "last and greatest" dream of using his innovations to help solve urban problems. Walt Disney originally envisioned EPCOT as a melting pot of ideas, a laboratory where Americans could test solutions for problems in transportation, education, housing, and business. What his successors have created doesn't come close to that dream.

To begin with, there are no permanent residents in the prototype community of tomorrow. People, it seems, only get in the way. "We wanted to stay flexible," Norm Doergis of WED Enterprises, Disney's engineering and design outfit, explained to a visiting group of M.I.T. alumni. "We could not accommodate permanent residents if we wanted to present our ideas to 24 million people this year."

Since there are no residents, there is no need to design creative approaches to housing or community life. Instead, Disney and its eight corporate partners use their considerable resources and ingenuity to sell themselves as the white knights of technology.

The Soft Sell

In Sperry's "gallery of custom-designed video games," for instance, I couldn't get through a game without being reminded that "Sperry helps make manufacturing more efficient for American manufacturers." And when I gave up trying to assemble the American flag and tackled Sperry's census quiz instead, I was informed that "Sperry makes sense out of U.S. census figures so Americans can plan their future."

Sperry's touch-sensitive computers ask questions such as: "With the advent of TV, do people read more or fewer books than they used to?" (More.) "Today, on the average, women have less than two children; in 1880, their counterparts had an average of how many?" (Seven.) "If you're into motorcycling, which state is the place to be?" (Michigan, because it has more registered motorcycles than any other state.) Now maybe I'm just a sore loser (I flunked almost every question), but I had a hard time figuring out how this information was going to help me plan my future.

In their respective exhibits, Exxon and the Bell Systems also can't resist the temptation to peddle their products. But the prize for blatancy goes to General Motors, which has a full lineup of its 1983 models on parade at the end of its exhibit. GM's exhibit, called "The World of Transportation," doesn't bother to look beyond the present—to a future with or without cars. Visitors spend most of their time riding through a nostalgic recreation of the past, peopled by postmen on wobbly bikes and Model T cars that backfire. All they see of the "future" is a shrunken model city suspended in the air much like an exhibit I saw 18 years ago at the New York World's Fair.

It is easy to spot—and even chuckle at—the hype. Far more subtle and disturbing is the way EPCOT's corporate sponsors manipulate information, giving visitors a one-dimensional view of world problems. For instance, in its multimillion-dollar Universe of Energy exhibit, Exxon pushes the message that "the world must continue to depend on imported fuels until the real breakthroughs come." Nuclear energy, coal, and synthetic fuels are also heavily promoted, but there is little mention of their environmental and economic drawbacks. In its walk-through exhibit on nuclear energy, Exxon categorically declares that "scientists have developed methods to handle, stabilize, and store radioactive waste safely to protect the human environment." That may be so. But in a comparable exhibit on energy at the Boston Museum of Science, the wording is more cautious: "Numerous technologies for high-level radioactive waste disposal are under investigation."

On the political problems that have hurt—some would say crippled—the nuclear power industry, Exxon has only this

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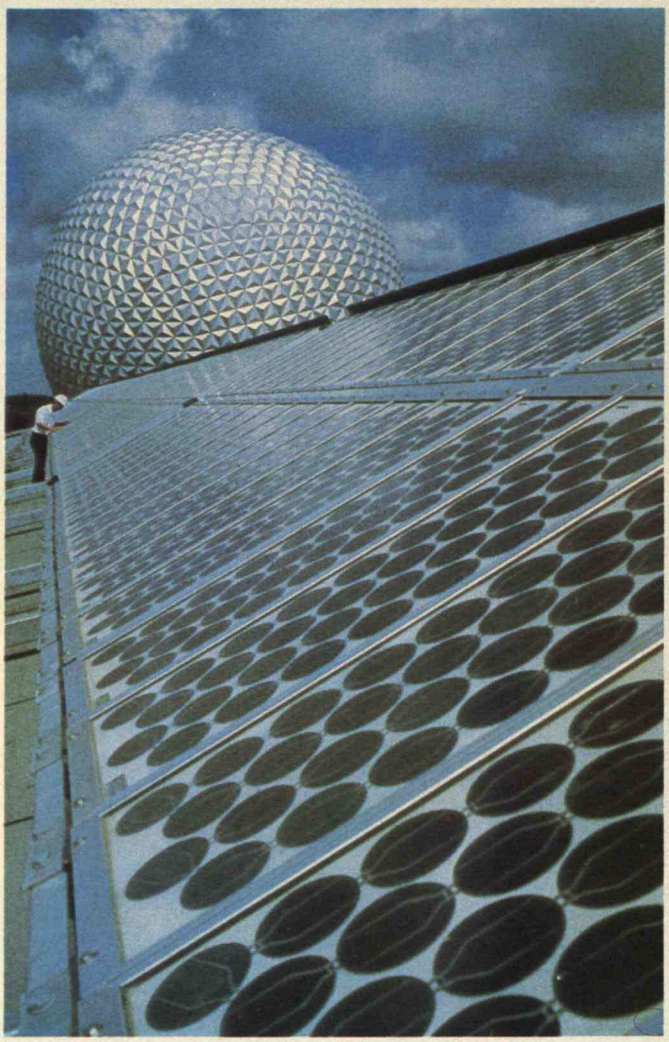
PHOTOGRAPHS: DISNEY WORLD

Exxon's exhibit begins with a look at how fossil fuels evolved over billions of years on earth. Visitors ride through a dramatic recreation of the prehistoric past, complete with sights (huge, menacing dinosaurs), sounds (claps of thunder), and smells (straight out of the Bronx Zoo). What dinosaurs have to do with fossil fuels remains unclear.

Disney workers tend leafy vegetables in the experimental greenhouse at EPCOT. The plants are grown in desert conditions with trickle irrigation, a vital water-saving technique that uses polyethylene tubes buried beneath the sand to deliver nutrients to the roots.



to say: "Nuclear energy is controversial but it is still a significant source of energy. Japan, France, and other countries are using nuclear power to build their bridge to the future." The unspoken punch line is: "So why aren't we?"

Exxon has a much more ambivalent attitude toward solar power. Company engineers have gone to the trouble of mounting 70,000 photovoltaic cells on the roof of Exxon's glittering Universe of Energy building. By calling to Disney's public-relations office, you can find out that those cells produce about 70 kilowatts of electricity, which are fed into EPCOT's electric grid. During the ride through the Universe of Energy, however, the narrator only briefly mentions these solar cells and the fact they help power the very cars the visitors are seated on. There is no explanation of how much electricity the photovoltaic cells produce, how they work, or what their potential may be as a decentralized source of energy. Instead, the narrator talks vaguely about sunlight as a viable source of energy "someday" in the distant future. That message is reinforced at Exxon's walk-through exhibit, where touch-sensitive computers stress the "major drawbacks" of solar and wind power.

The Technological Fix

Kraft's six-acre exploration of "The Land" is by far the most thoughtful and even-handed of the six major exhibits at EPCOT's Future World. (EPCOT has two parts: Future World, a ring of six exhibits focusing on technological progress, and the World Showcase, which includes pavilions from seven different countries.) Kraft's boat ride through an experimental greenhouse offers a fascinating glimpse of some innovative agricultural techniques. A large section of the greenhouse is devoted to growing lettuce and tomatoes without soil through "hydroponics." In that technology, vegetables are strung on an assembly line of polystyrene boards, and their roots are automatically misted with a solution that provides all the nutrients found in water and soil.

In another part of the greenhouse, vegetables and fruits are grown in desert conditions via trickle irrigation. In this water-saving technique, a network of polyethylene tube buried three inches below the sand delivers a concentrated nutrient solution to the plants' roots. Both of these technologies have been around for some time and are not going to dramatically alter the way crops are grown, says Leonard Topolski, professor of vegetable crops at Cornell University. Still, they do represent "possibilities for the future," Topolski says. He thinks Disney/Kraft's greenhouse experiments are a "good way to throw up these ideas so someone else can test them and make them work" on a large-scale basis.

Kraft's film on the environment, *Symbiosis*, also begins reasonably by discussing people's tendency to disrupt the delicate ecological system that sustains us. However, the film soon backs off from any real statement of concern. "Have we really begun changing our world and no longer adapting to it?" the narrator asks, and answers: "Not really. People have been changing their world for centuries."

(Left) Nearly 70,000 photovoltaic solar cells glitter on the roof of Exxon's "Universe of Energy" building. But inside the exhibit, visitors are too simplistically informed that solar power is not a viable source of energy for today.

(Below) A night-time view of Spaceship Earth, the Bell System's contribution to EPCOT. Physically impressive on the outside, Spaceship Earth is trite and superficial on the inside.

And with that pronouncement, the film pans to the stepped farms of Tibet. Are we to conclude that the industrial pollution of today is no more serious than the Tibetans' effort to shape their mountainous land into plots for farming?

The film moves on to address our abuse of the environment, but only in the soothing tones of past tense. "We misused our farmland and our forests. We dumped chemical wastes into our lakes. . . . And then we decided this tragic waste could not go on and we began to do something about it." The film focuses briefly on a successful effort to clean up Oregon's rivers and on the attempt to replant America's denuded hillsides. It never expresses any serious doubt that our problems are under control, nor does it mention the many demands for funds to clean up toxic-waste sites throughout the country. Instead the film asks, "To what do we owe this remarkable recovery? Ironically, technology," and wraps up with a glowing prognosis for the future.

A few exhibits ask more probing questions. Disney employees in the "Electronic Forum" query visitors for their opinions on such important issues as the nuclear arms buildup and America's Social Security dilemma. The multiple-choice answers are tabulated by computer and instantly shared with the audience. The day I was there, a majority of the all-white middle-American audience concluded that the United States has sufficient nuclear arms.

Kodak's three-dimensional movie *Magic Journeys*, which features three kids on a flight through fantasyland, is marvelous, and its "Journey into Imagination" ride presents an innocuous, if trite, look at creativity. The Bell Systems' exhibit—in between questions such as "What is the most important invention in the last 100 years? Bell Systems' data communications network"—offers some useful information about advances in microelectronics, software, and fiber optics. And the best may be yet to come with the opening of the still-unfinished exhibit on living in the twenty-first century, "Horizons," and the exploration of our oceans, "The Living Seas."

Behind the Times

The irony behind all of this is that the technology that Disney trumpets as "Future World" is very much "present world" and, in some cases, behind the times. The touch-me computers that provide information to visitors throughout EPCOT have already been tried and discarded as a communications tool by at least one major hotel chain (Sheraton). And Kraft's exhibit on agricultural advances includes no discussion of genetic engineering—the technology that may offer the most potential for improving our ability to grow crops.

Ironically, the only technology that comes close to "cutting edge" is the equipment Disney has installed to run EPCOT. To me, that is the real attraction of EPCOT—the computers that control every mechanical movement of the animated characters in Disney World, the telephone communication system that sends pulses of light through cables spun from glass to all parts of Disney World,

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LETTERS
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MCRAWFORD

Ten years of experience since the 1973 oil crisis raises doubts about how much good home energy conservation can really do. The problem is that homeowners aren't behaving as many policymakers hoped.

The Record of Home Energy Conservation: Saving Bucks, Not Btu's

BY BERNARD J. FRIEDEN AND KERMIT BAKER

ENERGY conservation is widely considered one of the most promising solutions to the nation's energy problems. But while the goal is not controversial, the means of achieving it are. Some conservation advocates argue for a strong government role, including regulations on the efficiency of houses and appliances, tax incentives to encourage investment in conservation, and direct grants for weatherizing homes. Other observers believe the most effective approach is to rely on the market—to let rising prices reduce consumption. David Stockman, director of the U.S. Office of Management and Budget, has summarized the market approach well: "We need do little more than decontrol domestic energy prices, dismantle the energy bureaucracy, and allow the U.S. economy to equilibrate at the world level. Energy supply and demand will take care of itself, no less efficiently than if the commodity were soybeans or Saran Wrap."

Energy used within the home—for heating, hot water, air conditioning, and home appliances—offers an especially attractive target for reducing consumption through market forces. Together these uses account for more than one-fifth of total energy consumption in the United States. The technology already exists for effecting great energy savings in these categories. Proponents of market solutions have been confident that consumer responses to greatly increased prices will bring about the desired results.

So far, their views have carried the day. Although federal controls have slowed the rise of energy prices somewhat, prices to consumers have nevertheless increased dramatically. For example, the price of natural gas went from $1.29 per thousand cubic feet in 1973 to $3.68 in 1980, and residential heating oil increased from $.23 to $.98 per gallon over the same period. Compared with such price increases, government programs to encourage home energy conservation through tax deductions, regulations, energy audits, and weatherization programs have been marginal in size and minimal in impact.

Energy Use Drops, but Not Enough

After the OPEC oil embargo, American families did make significant changes in their use of energy in the home. Before 1973, energy consumption per household grew steadily at an annual rate of around 3 percent. After 1973, the long-term growth trend came to a halt and home energy consumption went into moderate decline. According to Department of Energy estimates, average energy use per household decreased between the oil shock and 1980 by about 1.5 percent per year.

ILLUSTRATIONS: MICHAEL CRAWFORD

But consumers' response to the change in market prices was disappointing in several ways. First, one might have hoped that a near-quadrupling of crude-oil prices would produce a greater decline in household consumption. Second, conservation advocates contended that people would reduce consumption mainly by investing in measures to improve energy efficiency of buildings, with little sacrifice in comfort and attractive rates of return. For example, in a much-cited experiment, researchers at Princeton University's Center for Environmental Studies managed to reduce the amount of energy used for a home's space heating by two-thirds with an investment that would be recaptured in savings within ten years. They substituted items that were less costly than the energy used, such as insulation and extensive caulking to block air leaks, without reducing comfort or convenience. The authors of the major energy studies in the 1970s also attached this meaning to the word "conservation," arguing for conservation as an almost painless energy policy.

However, the Princeton case was exceptional; there has been relatively little conservation through investment behind the observed decline in household consumption since 1973. Instead, most of the decrease has been achieved through reduced living standards and coincidental changes in lifestyles. These changes include a shift of the population from cold to warmer regions of the country, a trend to smaller households, and a decline in real household income in the 1970s. Thus, the modest decrease in energy use brought about by the market is not the result either of improved buildings or of cost-saving investments, nor has it been achieved without hardship. Indeed, ten years of experience since the 1973 oil crisis raises doubts about the likelihood that large numbers of consumers will invest in conservation as a short-term energy strategy. Experience also suggests that new policies are needed to improve the operation of the market for conservation investment.

Simple Steps, Few Investments

Advocates of the market as the principal tool for inducing a decline in energy consumption proved right in one important respect. Numerous studies of consumer attitudes suggested that appeals to a sense of civic duty were unlikely to have much effect. For example, Robert Perlman and Roland Warren of Brandeis University studied home energy use in three cities—Hartford, Conn., Mobile, Ala., and Salem, Ore.—in 1973-74. They found that only 36 percent of the people surveyed considered the energy shortage to be real; most believed it was contrived by the oil companies to increase their profits. Moreover, even those who believed the oil crisis was genuine were unwilling to take unusual steps to cut their fuel consumption; both believers and skeptics had altered their energy consumption by about the same extent. And when interviewers asked people whether they had reduced their energy use because of price, availability, or a sense of duty, most identified price as by far the most important reason.

To save energy, these homeowners did things that were inexpensive and produced quick results. For example, 49 percent of the households reported that they turned down the thermostat during the winter, and two-thirds of the households with air conditioning reported that they used it less during the summer. Most families also cut back their use of appliances. However, few people made investments that would lead to greater efficiency in the use of energy: 17 percent added weatherstripping to windows and doors at a median cost of under $100; 13 percent installed storm windows or doors at a median cost of $300 to $400; and 10 percent insulated floors, walls, or ceilings at a median cost of $100 to $200. The story, therefore, was basically one of minor cutbacks accompanied by little conservation. The market did allow each family to decide for itself what kind of adjustment was least painful, and the initial energy savings were helpful. But overall, energy price increases working through the market system somehow failed to persuade many families to invest much in conservation.

Impact by Income Levels

The three-city survey pointed up another shortcoming of the market's effect. Poor families turned out to be the most responsive to price increases, and in some cases this led to much more than minor inconveniences. Families with incomes under $5,000 made greater percentage reductions than middle- and upper-income groups in their use of energy. For example, poor families reduced their energy use for heating by 14.9 percent, while the average reduction for all families was 13.3 percent. For some low-income families, economizing on home heating meant living with temperatures well below reasonable com-

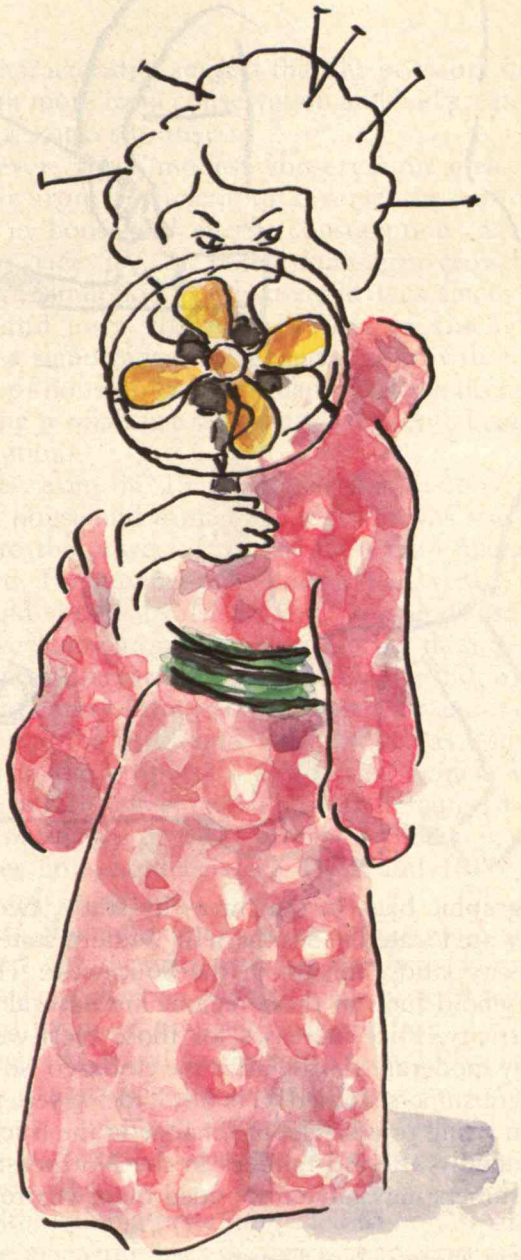
fort levels or health requirements.

Even more striking evidence of the different responses of people at different income levels was produced by a study of five southwestern cities in 1975. William H. Cunningham and Sally Cook Lopreato of the University of Texas compared consumers who took more measures to reduce their energy use with consumers who took fewer. They studied actions ranging from adjusting thermostats and turning off lights to conservation investments such as buying energy-efficient furnaces and water heaters and installing storm windows. The poor ranked highest in every category in their efforts to reduce energy use. Since most of the cutbacks did not involve monetary costs, the extra responsiveness of the poor is not surprising. But even when the measures did involve spending money, the poor still outranked other income groups.

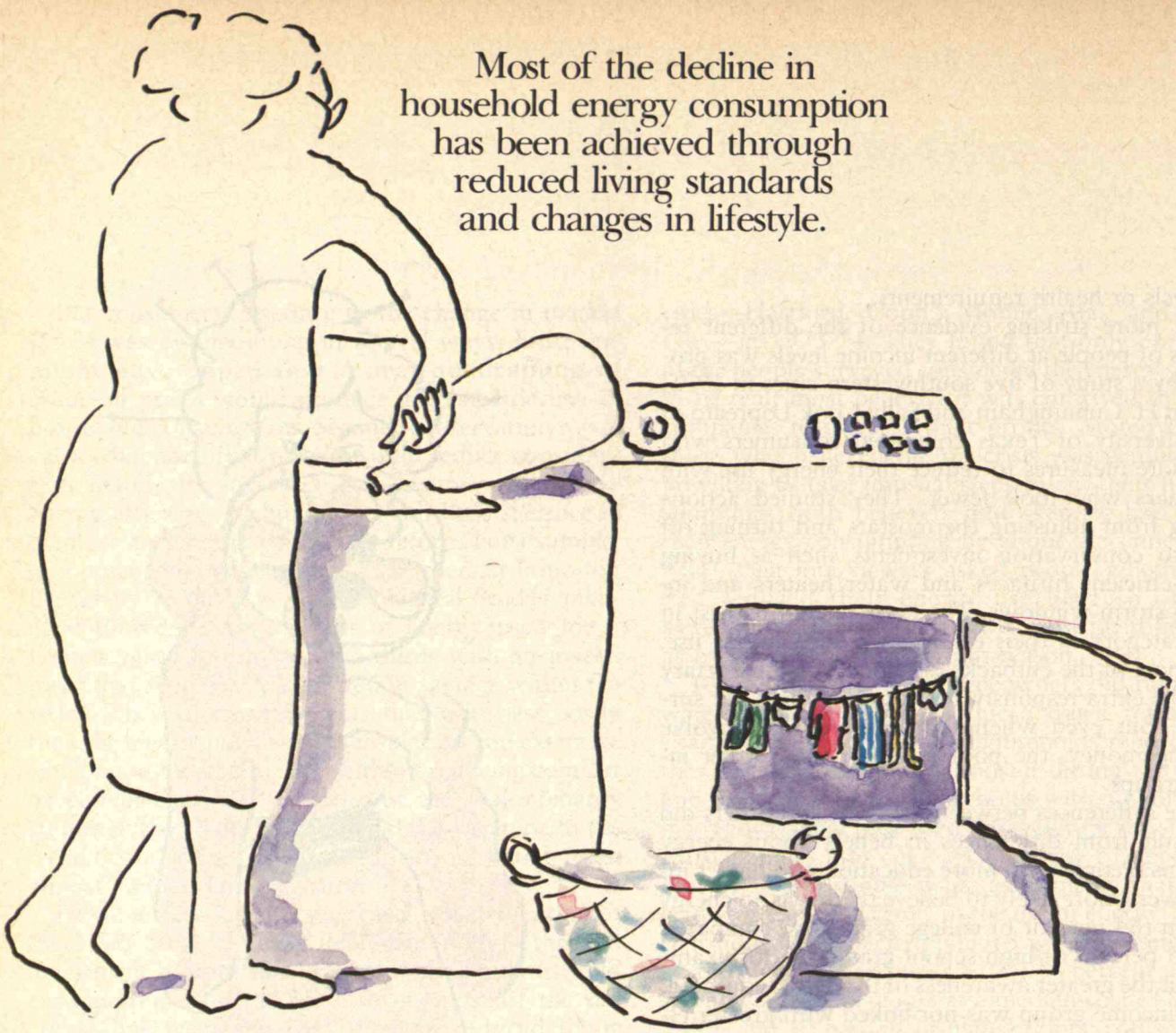
These differences between the poor and others did not result from differences in beliefs about energy problems. People with more education and higher incomes were more likely to believe there was an energy problem (64 percent of college graduates, compared with 45 percent of high-school graduates, for example). But the greater awareness of the better-educated, higher-income group was not linked with greater efforts to reduce energy use. On the contrary, lower- and middle-income consumers, though less knowledgeable about energy matters, outdid the more affluent in their attempts to reduce energy consumption. Indeed, those with lesser incomes made their cutbacks with a special sense of frustration because they did not believe that the energy problem was real.

The fact that the market approach to reducing energy consumption fell disproportionately on the poor helps to explain why overall conservation was limited. Even though low-income families made greater proportional reductions in energy use, and even though their cutbacks represented greater sacrifices, their actual energy savings proved small. Before the 1973 oil crisis, the average family with income below $5,000 used only one-third as much energy as the average family with income above $15,000. Despite their greater efforts, families in the low-income group succeeded in saving a total of only one-third as much energy per family as those in the higher-income bracket.

One qualification is important in reporting how these families responded to energy price increases right after the 1973 oil embargo: they may reflect a



Energy price increases have failed to persuade many families to invest much in conservation.



geographic bias. In the three-city study, two of the cities are located in Southern or Western states; in the five-city study, all are in the Southwest. The main household fuels in these regions are natural gas and electricity. Price increases for those fuels were relatively moderate shortly after the embargo, so most of the consumers studied were not under severe pressure from rising prices. The big change in the price of fuel oil mainly affected families in the Northeast, where consumers may have responded more vigorously.

Saving Money, Not Energy

The adjustments people made immediately following the oil shock were only the first response to rising energy prices. At a time when many people were uncertain how long the energy crisis would last, or indeed whether there was one, the logical strategy was to make minor sacrifices in comfort and convenience. After a few years, the continuing rise in energy prices prompted more familes to make investments as well as cutbacks. Indeed, by 1977-78, a significant proportion of families at all income levels was making investments—about 39 percent, according to the U.S. Department of Energy's National Interim Energy Consumption Survey. However, people did not necessarily invest in equipment that would make their homes more energy efficient. In a market system, the object was to save money, not Btus, and some investments enabled people to save money without reducing their energy use.

Large numbers of households switched from burning oil to burning gas. By September 1979, the Long Island Lighting Company had received 33,000 requests for residential conversions, while other utilities in the Northeast also reported making thousands of home fuel conversions. The costs ranged from about $500 for converting a burner in a furnace from oil to gas to about $2,000 for installing a new gas-fired furnace. The switches involved not only owner-occupied homes but also rental properties. In the largest such conversion, the Lefrak Organization in New York converted 54 apartment buildings housing 9,200 families to gas heat. In total, a survey by the American Gas Association indicated that at least 600,000 families converted to gas in 1978 and 1979.

Although price controls over natural gas were being phased out at the time, gas prices were still

lower than oil; switching promised to cut heating bills by about 40 percent for a typical single-family home. But unless the homeowner increased the efficiency of the heating system at the same time, the house would continue to use at least the same number of Btus.

Other fuel switches produced objectionable side effects. Thousands of families in the Northeast installed wood stoves to provide part of their heat. At least two-thirds of all Vermont houses had wood stoves by late 1979, according to a state survey. In Massachusetts, almost one-third of all households burned wood in 1978-79. Although wood is a potentially renewable resource, much of the New England supply comes from private woodlots whose owners do not replenish what is cut. Growing use of wood stoves has also led to complaints about air pollution. Moreover, many wood stoves have not been installed properly and are fire hazards. In 1979, 96 deaths in Maine and Vermont were attributed to wood-stove fires; these states had no such deaths reported a few years earlier.

Still, some genuine conservation measures were taking place. Two surveys—the Department of Energy's National Interim Energy Consumption Survey in 1978-79, and a local survey conducted by the city of St. Paul, Minn., early in 1980—asked people which conservation measures they had undertaken. (*See the chart on page 29.*) The national survey asked for a report on activities in the two prior years, while the St. Paul survey asked about conservation activities at any time in the past. The range of activities was considerable, but the level was low. The national survey found no single conservation measure that more than 10 percent of the people had taken. The St. Paul survey found only one measure—insulating the attic—that more than half of the households had ever done, even though Minnesota winters are severe.

According to the national survey, more than 60 percent of households spent nothing at all on conservation measures during the two years, while about 15 percent spent more than $1,000. This suggests that while millions of Americans may have been buying insulation for their attics, many millions more were not. The average expenditure per household was $266. In contrast to the period immediately after the 1973 oil embargo, those now investing in conservation had higher incomes than those that did not; they were also younger, lived in older houses, were more likely to be homeowners, and used more energy. These characteristics suggest that the investors stood to benefit more from conservation and had greater financial resources to invest.

However, these modest conservation measures were far from sufficient to reverse the national growth in household energy consumption (*see the chart on page 30*). As noted, long-term growth in energy consumption per household was finally arrested and even slightly reversed in the latter 1970s—a significant achievement. But growth in the number of households more than offset the decrease, producing a small net rise in total residential energy consumption.

Besides, even the 13 percent decline in consumption per household from 1972 to 1980 was less of a tribute to the power of conservation than might be supposed. The number of persons in the average U.S. household shrank by 10 percent, so energy use per capita went down only 3 percent during these years. Other nonconservation factors included a shift of the population away from the cold Northeast and North Central into the South and West, as well as a steady increase in the proportion of married women who worked, which left empty homes that required less heating during the day. A 7 percent decline in real income per household between 1972 and 1980 also helped curb energy use.

Further, the reduction in home energy use is small compared with the price increases that helped bring it about (*see the chart on page 30*). The price of fuel oil increased by more than 400 percent from 1972 to 1980, that of natural gas by more than 200 percent, and that of electricity by about 120 percent, as measured by the Consumer Price Index for fuels. In comparison, the overall Consumer Price Index increased by 97 percent.

But although big price jumps led to only small reductions in energy use, the price changes did have some effect: the years with the greatest increases in fuel prices, 1972-74 and 1978-80, were also the years in which household energy use dropped the most. The regions where energy costs increased the most were also the ones where household energy use dropped the most. For example, in New England some 70 percent of homeowners heat their houses with oil. There energy consumption per household declined by 23 percent between 1972 and 1980. In the Southwest and Pacific regions, where more than 70 percent of the homes use gas for heating, energy use per household declined by 5 and 15 percent, re-

More than 60 percent of households spent nothing at all on energy conservation during 1978 and 1979, according to a national survey.

spectively.

However, average figures on energy consumption do not reveal the wide variations among families. For example, we analyzed utility expenditures between 1977 and 1979 for 5,000 households being tracked by the University of Michigan Panel Study of Income Dynamics. The changes in household energy use over this two-year period were surprising. About 45 percent of the households reduced their consumption by at least 20 percent, while 10 percent *increased* their consumption by at least 20 percent.

Two factors were closely associated with reductions in energy consumption. Households in the panel study with higher incomes and those spending a higher proportion on utilities averaged greater reductions in energy use. These results reinforce the findings from the national survey cited earlier. Thus, it seems clear that by the late 1970s, the families who reacted most decisively to rising energy prices were those who used enough energy to feel the increases as a significant burden, and those who had enough income to afford to invest in conservation. While we do not know how many of the households in the study reduced their energy consumption through cutbacks and how many increased energy efficiency, by this time investments in conservation were fairly widespread even though most dollar outlays were small.

Requirements for Conservation

Thus, there are ample indications that the market has worked more by curtailing householders' use of existing facilities than by inducing alterations in those facilities to conserve energy. That conclusion is hardly surprising. For homeowners to be persuaded to invest as a result of market stimuli, a number of conditions must usually be satisfied. Owners have to have some basis for estimating their return, including a credible estimate of future fuel prices. They must find energy costs burdensome enough to warrant action, and they must have enough money to invest in home improvements. Beyond that, householders need a credible source of advice on how to make their homes more efficient. Although some improvements may be obvious, such as insulating an attic, others, such as blocking air-infiltration routes, require skilled judgments.

While many families feel the pain of energy bills and have money they can spend for home improvements—not to mention having homes that are less than ideally equipped for conserving energy—uncertainties about future fuel prices and appropriate conservation measures are serious obstacles. Homeowners often turn to energy "auditors" for suggestions about improvements. However, not only do auditors' recommendations often differ, but their estimates of energy savings often prove unreliable.

For example, Arthur Rosenfeld of the Lawrence Berkeley Laboratory compared the fuel savings estimated by professional energy auditors with the actual fuel savings after building modifications were completed. Of a total of 18 audits, 5 underestimated fuel savings and 9 overestimated them. Only 4 were within 20 percent of the actual savings, and the actual saving commonly differed from the estimate by a factor of 2. In one extreme case, an estimated fuel saving of 42 percent turned out to be an actual fuel saving of only 2 percent. Although these audits were for commercial buildings, we believe the wide gaps between estimated and actual savings are also typical of home energy audits. These gaps occur partly because of the technical uncertainties in estimating the thermal characteristics of homes, and partly because actual savings vary according to differences in family behavior.

The difficulty of predicting energy savings is exacerbated by the fact that relatively safe investment alternatives such as money market funds have yielded high rates of return. In the five-city survey of households, people were asked how much time they would be willing to wait to recover their investment in energy-saving equipment. Those with incomes below $10,000 said they would wait six months to recover an investment of $100 on home insulation, and about one and one-half years to recover an outlay of $500. Those with higher incomes were willing to wait about one and one-half years for a payback on a $100 insulation investment, and up to four and one-half years for a $500 investment. Payback periods for storm windows followed a similar pattern.

In a period of high inflation, when other low-risk investments offered annual returns of 14 percent or more, demanding a payback within a few years on an uncertain investment does not seem unreasonable. Yet those who see a big potential in conservation usually assume that people will invest for much lower returns. Payback on the Princeton group's model house, for example, was estimated at ten years. And *Energy and America's Future*, the thorough study by

Percent of households undertaking selected energy conservation activities.

	St. Paul survey	National survey
Minor measures		
Install a clock setback thermostat	10%	3
Install water flow restrictors	12	n.a.
Insulate hot water pipes	21	5
Insulate hot water heater	23	n.a.
Install fireplace glass doors or chimney cap	16	n.a.
Major measures		
Install shutters that can close	n.a.	1
Install storm windows	n.a.	10
Install storm doors	n.a.	9
Insulate attic	57	10
Insulate the basement/crawl space	35	4
Insulate walls	43	6
Install more efficient furnace	25	4
Install new water heating equipment	n.a.	6
Install electric heat pump	n.a.	1

n.a.—not asked

Energy price increases failed to persuade many families to invest much in conservation. Two studies—the Department of Energy's National Interim Energy Consumption Survey in 1978-79, and a local survey by the city of St. Paul, Minn., in 1980—asked people which conservation measures they had undertaken. The range of activities was considerable, but the level was low.

Indeed, 60 percent of the households in the national survey spent nothing at all on conservation. This suggests that while millions of Americans may have been buying insulation for their attics, many millions more were not. And in the St. Paul survey, there is no evidence that many families plan to try to conserve substantially more energy in the future.

Resources for the Future, also assumes that consumers will make conservation investments with a ten-year payback. However, those assumptions were at variance with what the market had to offer during the 1970s.

Rental Housing: Let The Meter Run

About one-third of America's families live in rental housing, where conservation activity is even less in evidence. What's more, the prerequisites for a serious conservation effort for rental housing are even more demanding. The congressional Office of Technology Assessment recently investigated the prospects for improving energy efficiency in rental buildings, concluding that several conditions will have to be met before the owners invest in conservation. Once again, the requirement of a reasonable return on an investment looms large. And once again, the owners must have the means—including information, time, and financial resources—to make the investment. But the authors contend that inertia plays an especially important role for rental buildings. Before owners will be moved to act, they must feel that their existing or future rate of return is noticeably threatened, and they must have access to organizations that they feel will analyze and execute the job effectively.

The obstacles to meeting these conditions are formidable. In almost half the multifamily apartments in the country, fuel and utility use is metered directly to the tenant. Many building owners who had previously included fuel and utility use in the rent responded to energy price increases by installing separate meters for each unit. These owners have little reason to make conservation investments, unless greater efficiency adds to the rental value of their apartments.

Even when there is no tenant metering, other factors often work against conservation investment. Some building owners are concerned more with the tax shelter that ownership provides than with cash flow. Others, like ordinary homeowners, are unwilling to invest because of uncertainty about predicted energy savings, or because they cannot find a feasible way to finance the improvements. The increase in interest rates during the 1970s and early 1980s added

U.S. household energy consumption and fuel prices

	Total household consumption (trillion Btu)	Consumption per household (million Btu)	Consumer fuel price indexes (1967 = 100)		
			Fuel oil	Natural gas	Electricity
1970	13,367.6	210.8	113.5	111.5	109.9
1971	13,918.1	214.9	116.4	120.5	116.0
1972	14,530.0	217.9	117.0	125.1	120.2
1973	14,632.9	214.4	171.8	133.1	129.0
1974	14,369.5	205.7	223.9	155.8	157.5
1975	14,440.0	203.0	245.0	187.2	171.4
1976	14,971.9	205.5	261.2	221.9	182.4
1977	15,212.6	205.2	288.7	249.2	190.7
1978	15,523.5	204.2	313.5	277.0	202.2
1979	15,419.9	194.9	507.3	332.6	224.7
1980	15,272.2	190.0	610.0	381.5	262.3
Percentage change: 1972–1980	+5.1	−12.8	+421.4	+205.0	+118.2

After the 1973 OPEC oil embargo, energy consumption per household went into moderate decline. But the big jump in fuel prices prompted smaller than expected investments in conservation and yielded only minor energy savings. Most of the decreases came through reduced living standards and changes in lifestyles such as a population shift from cold to warmer regions.

The modest conservation measures taken by U.S. families were not enough to reverse the national picture, since an increase in number of households actually produced a net rise in total residential energy consumption. However, price increases did have some effect. The years with the greatest increases, 1972-74 and 1978-80, were also the years in which household energy use dropped the most.

an especially serious obstacle to raising capital through refinancing.

Some property-management firms have sought to reduce the risks of error inherent in estimating the yield on conservation projects by taking on a large number of buildings. For example, one firm operating in New York and Washington, D.C., will operate the heating, cooling, and hot-water systems of a building on a long-term basis for a fee 10 to 20 percent lower than the owner's current costs. This company can then profit from investments that improve the systems. However, such operations are unlikely to spread rapidly, because the rate of return depends as much on the behavior of the occupants as on the nature of the investment.

Rethinking the Conservation Strategy

So far, then, major price increases have brought only small reductions in household energy use. Because so little conservation has been done, the technical potential remains great. Energy efficiency can be substantially improved by such measures as better heating systems, better insulation, and zoned heating and cooling. However, the key question for policymakers is how to convert the potential into actual energy savings. This is a difficult challenge, since little in the picture suggests that people will inevitably take such action on their own.

For example, even in the cold city of St. Paul, there is no evidence that many families plan to try to con-

The potential for conservation remains great. The question for policymakers is how to convert that potential into actual energy savings.

serve substantially more energy in the future; in fact, some evidence points to the contrary. In the 1980 survey, the average household had already completed three of nine activities involving at least moderate expense listed in the survey (how well is not known). On average, families said they had no intention of doing four of the nine, either because the activity did not apply (for example, no crawl space to insulate), because they felt it was the landlord's responsibility, or because they believed the activity would not save enough energy to make it worthwhile. Only two activities remained that the average household would consider. The most common reasons people offered for why they had not yet done them were lack of time and lack of money. This means that with some assistance or convincing, these households might be expected to take two conservation measures in the future.

Still, the experience of the 1970s is not necessarily the last word on prospects for energy conservation. Studies suggest that long-term responses to energy price changes are likely to be greater than short-term ones, with some studies suggesting that a doubling in price would eventually cut consumption in half. But if this long-term response depends on replacing inefficient houses with energy-saving models, as appears to be the case, then the long term will be very long indeed. At current replacement rates, more than 50 years will pass before half the existing homes in the country are taken out of use.

None of the obstacles to home energy conservation can be overcome readily by raising the price of energy—indeed, massive increases would be necessary to induce the drop in home fuel consumption that many energy experts consider feasible. When David Stockman suggested that the market would take care of energy no less efficiently than if the product were Saran Wrap, he overlooked the fact that finding substitutes for energy is a harder task. However, public policies can help make conservation investments easier—particularly measures for reducing risk and increasing the availability of information. A comparison with automobiles is instructive. Today, people can buy an energy-efficient car based on its mileage rating, but buying an energy-efficient home is more troublesome. If the government took the lead in developing a rating system for the thermal characteristics of homes and encouraged its widespread use, homebuyers could shop for a class A or class B house instead of class D or E.

Aside from public policy, changes in the economy may also make conservation investments more attractive. The recent decrease in the returns on money-market funds, for example, could well make consumers take a fresh look at conservation investments that promise a return of 9 or 10 percent.

Yet the obstacles also suggest the need to rethink our residential energy conservation strategy. Even with new policies designed to make the market work better, the results of home conservation are likely to fall far short of early expectations. The authors of the Harvard Business School report, *Energy Future*, wrote in a much-quoted passage that the United States could cut its energy consumption by 30 to 40 percent through conservation. Nothing in recent experience supports an estimate in this range for the foreseeable future. A decade after the 1973 oil crisis, the residential sector has seen no reduction at all in total energy use.

The early enthusiasm for home energy conservation clearly led to many exaggerated claims. Advocates of a conservation strategy defined the very term "conservation" seductively, portraying it as a solution that was highly feasible, painless, and safe. We know now that its feasibility is questionable and it is not painless, since it involves financial sacrifices, the risk of a low return on investments, and potential health and safety problems. The fire hazards of wood stoves have already been noted. And urea formaldehyde foam, a popular insulation material added to a half-million homes, has been identified as a cause of cancer. (It is easy to imagine the furor that would have resulted from a nuclear-power accident that led to 96 deaths and exposed a half-million families to a cancer hazard.) Thus, a market-based conservation policy may be less hazardous than some energy strategies, but it is not as safe as it once seemed.

Conservation still merits public support, but without a halo. After ten years of experience, it is time to adjust both our policies and our expectations.

This is the first in a two-part series on energy conservation. The second article, "Energy Conservation: The Human Dimension," will discuss ways to bring energy conservation home to the consumer.

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The Trouble with Fusion

BY LAWRENCE M. LIDSKY

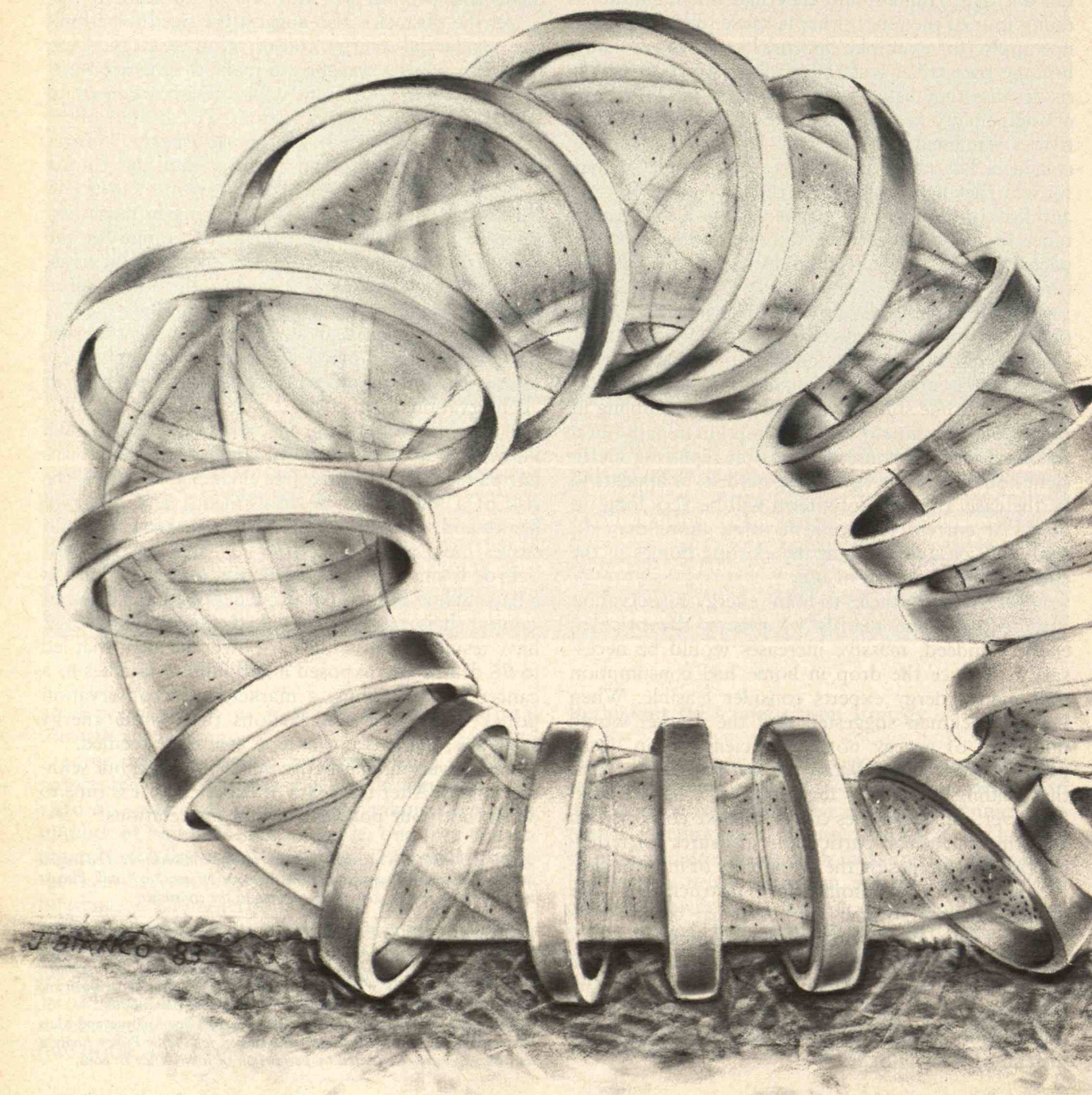
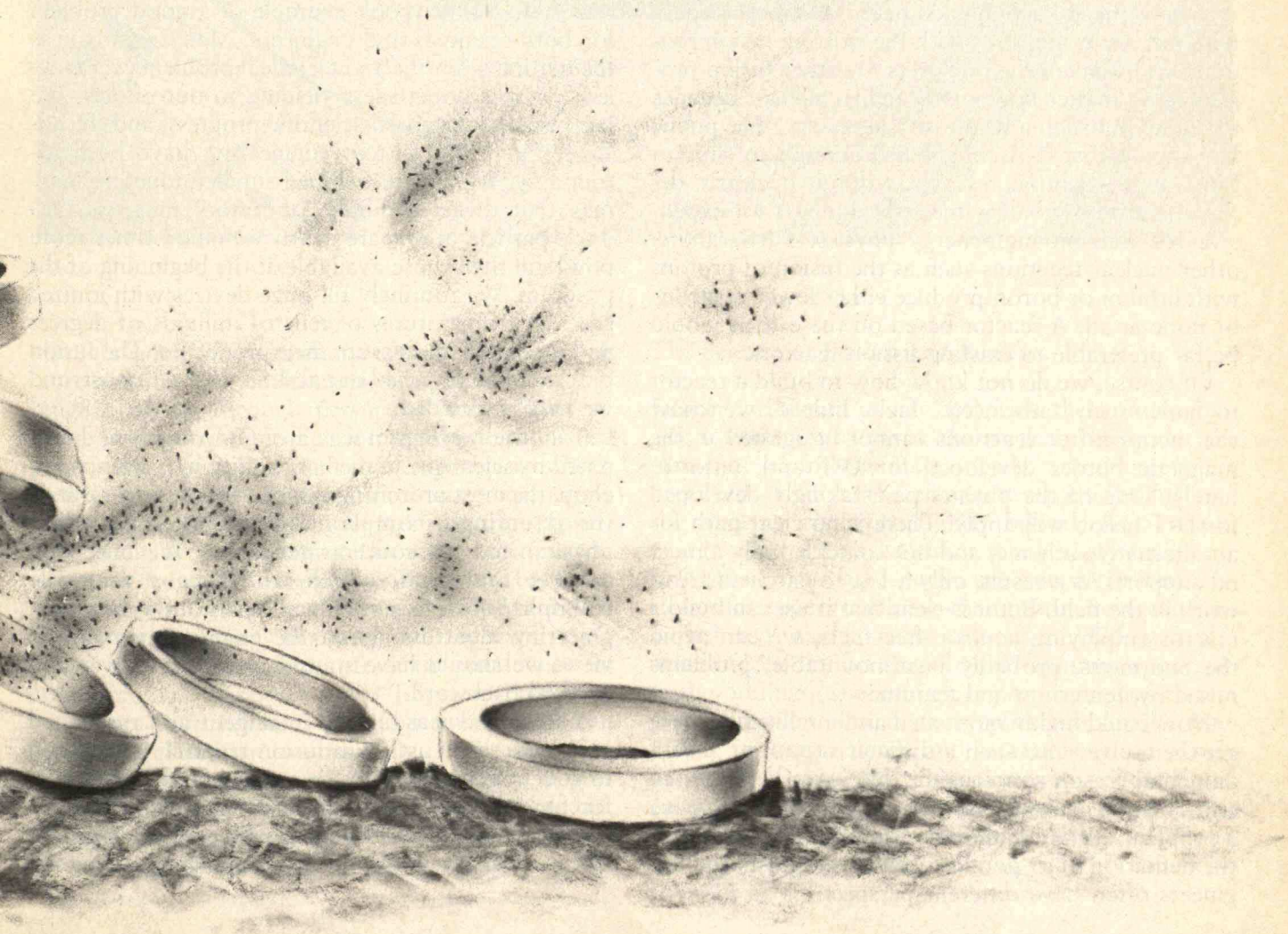


ILLUSTRATION: JANE BIANCO

THE technically advanced nations of the world will spend over $1 billion this year in the quest for controlled thermonuclear fusion power. This program has been sustained for 30 years with steadily mounting commitments of money and the dedication of an international group of scientists and engineers. Our knowledge of the related physics has grown enormously in the effort. Now the solution of the scientific problem appears to be almost within our grasp, and many assume that with it will come that technological Holy Grail: virtually unlimited, environmentally safe energy. But that outcome is unlikely. Instead, the costly fusion reactor is in danger of joining the ranks of other technical "triumphs" such as the zeppelin, the supersonic transport, and the fission breeder reactor that turned out to be unwanted and unused.

The dominating goal of the fusion program is to produce a reactor fueled by deuterium and tritium, isotopes of hydrogen containing one and two extra neutrons. This choice of fuel greatly eases the problem of achieving an energy-producing fusion reac-

Long touted as an inexhaustible energy source for the next century, fusion as it is now being developed will almost certainly be too expensive and unreliable for commercial use.



Scientists routinely fill vacuums with ionized gases, or plasmas, at temperatures of tens of millions of degrees Centigrade (above). To achieve a sustained fusion reaction, scientists at the Princeton Plasma Physics Laboratory plan to heat plasma inside this vacuum vessel (right) to temperatures 20 million degrees hotter than have so far been achieved.

tion, but the choice also has features that make it far more difficult to turn that energy source into a useful power plant. The most serious difficulty concerns the very high energy neutrons released in the deuterium-tritium (D-T) reaction. These uncharged nuclear particles damage the reactor structure and make it radioactive. A chain of undesirable effects ensures that any reactor employing D-T fusion will be a large, complex, expensive, and unreliable source of power. That is hardly preferable to present-day fission reactors, much less the improved fission reactors that are almost sure to come.

When these drawbacks become more widely realized, disillusionment with the existing fusion program will weaken the prospects for other fusion programs, no matter how wisely redirected, for decades to come. But such a result isn't necessary. The public has shown that it is enlightened enough to support long-range scientific research without a clearly defined near-term goal; witness the support for expensive research on high-energy physics. Furthermore, other nuclear reactions such as the fusion of protons with lithium or boron produce either fewer neutrons or none at all. A reactor based on these fuels would be far preferable to existing fission reactors.

Of course, we do not know how to build a reactor to ignite such "advanced" fuels. Indeed, we know that neutron-free reactions cannot be ignited in the magnetic bottles developed for D-T and, unfortunately, little of the physics painstakingly developed for D-T fusion will apply. There is no clear path for an alternative scheme, and not coincidentally almost no support. As a result, only a few researchers are at work in the field. But it is clear that if we can build a reactor employing neutron-free fuels, we can avoid the enormous, probably insurmountable, problems posed by deuterium and tritium.

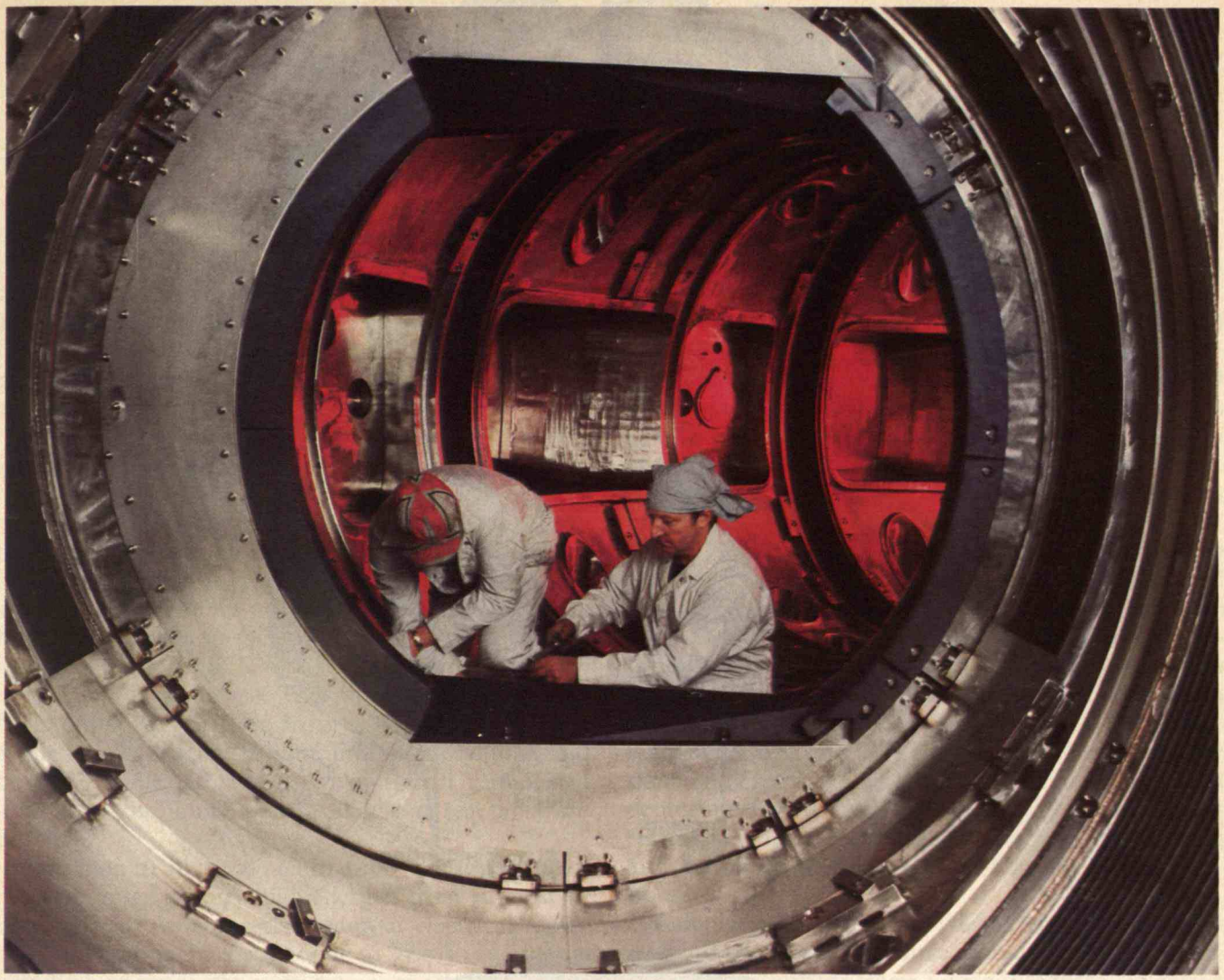
How could highly motivated and intelligent people get themselves into such a difficult situation? A fundamental reason concerns the difference between scientists' and engineers' view of what it means to solve a problem. Although they are usually able to agree on the definition of a "good problem," scientists and engineers often have different perspectives as to what constitutes a "good answer."

Good problems challenge our abilities to the limit but ultimately are solvable—that is, they are not so difficult that the time spent is wasted. In both science and engineering, the greatest satisfaction accrues to those solving a problem first, even though "better" (simpler or more complete) answers are often found later. In science, such answers can coexist peacefully and are usually mutually illuminating. However, engineering answers must meet economic and social demands from the start, and fundamentally different answers rarely coexist for long.

Fusion is a textbook example of a good problem for both scientists and engineers. Many regard it as the hardest scientific and technical problem ever tackled, yet it is nonetheless yielding to our efforts. We have made substantial scientific progress, and the advances in fusion-system engineering have been astounding. We have developed superconducting magnets that dwarf ordinary laboratory magnets. Today's particle beams are nearly a million times more powerful than those available at the beginning of the program. We routinely fill huge devices with ionized gases at temperatures of tens of millions of degrees and use lasers to measure their properties. The fusion program has stretched our abilities to the utmost, and we have responded.

The fusion program was, from its inception, dominated by scientists. In the best tradition of science, we chose the most promising target—D-T fusion—out of the dauntingly complex areas of thermonuclear physics, and we concentrated on it. We may well achieve that goal, which would be a scientific triumph. But the scientific goal turns out to be an engineering albatross. From the engineering point of view, we should have started from the answer and worked backward.

The second reason why intelligent and motivated people were led astray in fusion research is common to government programs that must compete annually for funds. There is a strong temptation to choose a near-term answer over a more rational long-term answer, even though this choice precludes reaching the



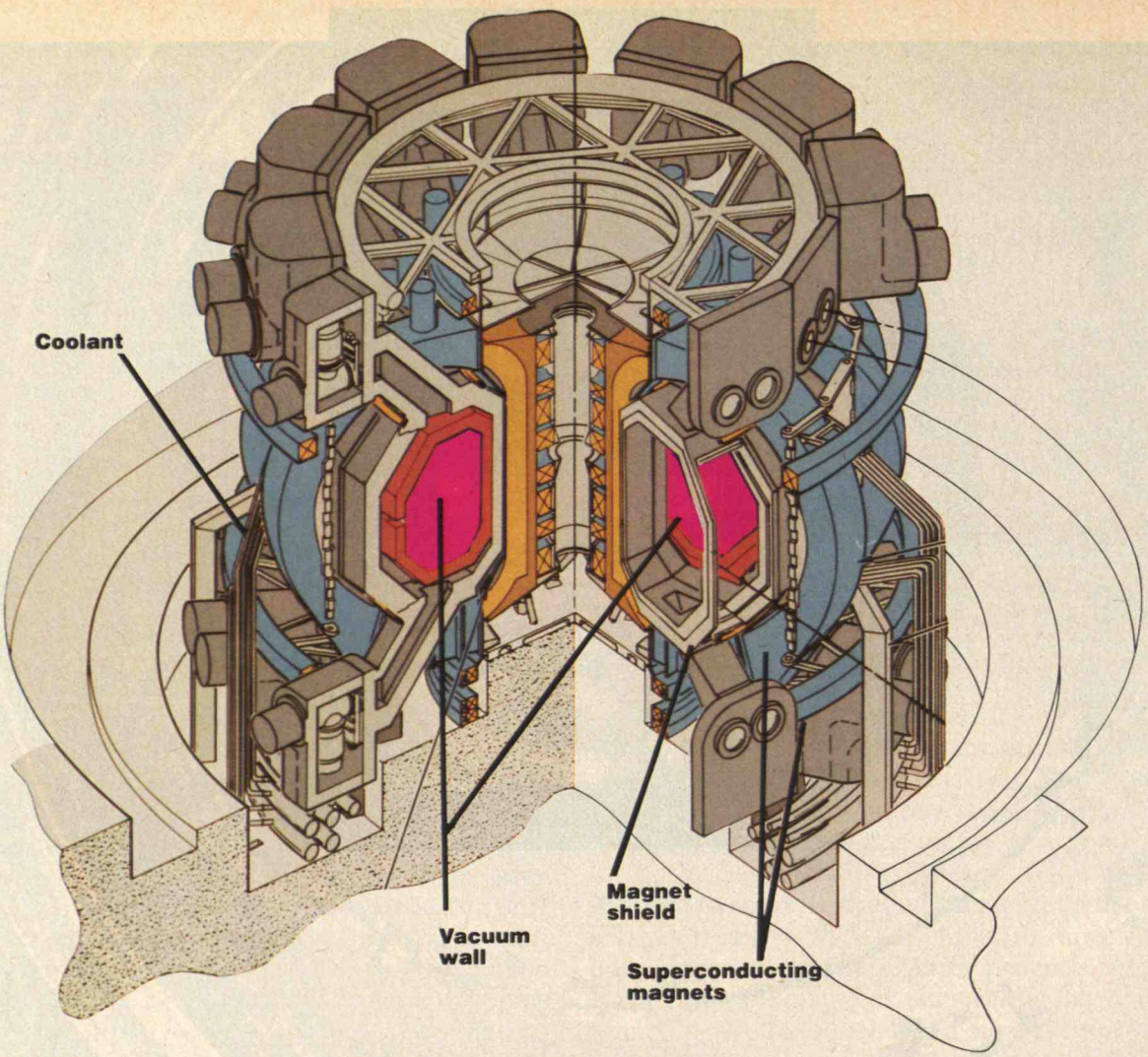
ultimate goal. The alternative would be the much more difficult task of developing support for a long-range program through persuasion and education. There is a related disinclination to adjust established plans, even if perceptions change. Indeed, it is considered dangerous even to admit uncertainty in a highly visible public program. Once established, an explicit goal, such as generating commercially competitive electricity from D-T fusion, is not easy to change.

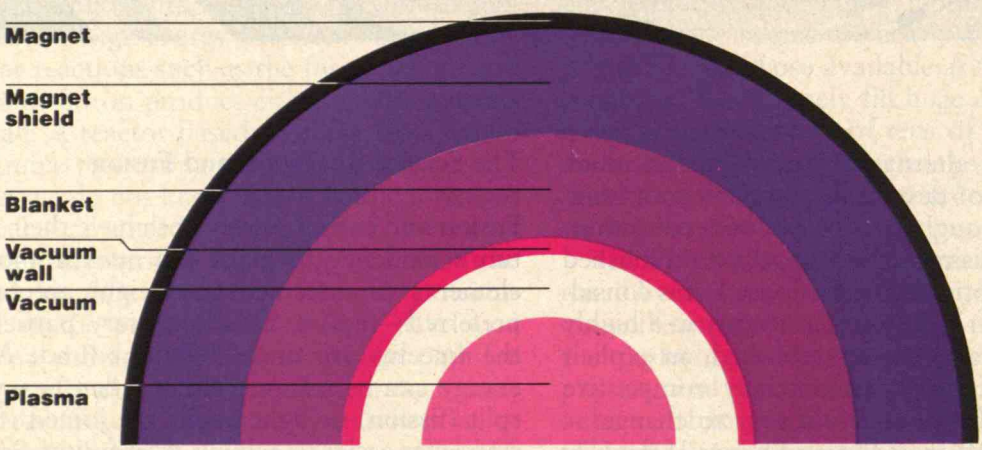
As a result, the Office of Fusion Energy of the U.S. Department of Energy has promised that it will, early in the next century, demonstrate the production of large amounts of power via D-T fusion. Producing net power from fusion is a valid scientific goal, but generating electricity commercially is an engineering problem. The requirement is to develop a power source significantly better than those that exist today, and D-T fusion cannot provide that solution. Even if the fusion program produces a reactor, no one will want it.

The Science of Fission and Fusion

Fusion and fission power both have their roots in nature's tendency to favor the nuclear moderate: the elements of intermediate weight are energetically preferred—that is, the elementary particles forming the nucelus are more tightly bound. As a result, energy can be released either when heavy nuclei are split (fission) or light nuclei are joined (fusion). Fission is far easier to achieve than fusion. Several atoms with heavy nuclei, such as uranium-235 and plutonium-239, are on the verge of splitting spontaneously; adding a single nuclear particle causes instantaneous fission. The nucleus splits into smaller fragments, releasing energy and several neutrons. These neutrons, because they are electrically neutral, can easily penetrate the electric barriers surrounding uranium and plutonium nuclei to cause additional fissions. This, of course, is the so-called "chain reaction."

PHOTOGRAPHS: PRINCETON PLASMA PHYSICS LABORATORY





The schematic cross-section of proposed fusion reactors (bottom) has remained essentially unchanged from one proposed in a 1961 textbook. In the most likely scheme, called the "tokamak" (top), the tubular reactor is curved to form a torus (or doughnut).

Temperatures in the plasma where fusion takes place would approach 150,000,000° C. The inner surface of the vacuum (or first) wall (pink) encircling the plasma will be subjected to intense heat and bombardment by damaging neutrons from the reaction. The "blanket" containing lithium, outside the first wall, absorbs these neutrons to "breed" tritium for fuel. The engineering will be complicated by the fact that lithium reacts explosively with air and water.

On the reactor's exterior, the superconducting magnets that contain the plasma must be cooled almost to absolute zero. Hence the shielding to protect them from the extreme heat.

Despite the potential for problems in such a reactor, hands-on repair will be impossible because of radioactivity. All in all, the proposed fusion reactor would be a large, complex, and unreliable way of turning water into steam.

DIAGRAMS: OMNIGRAPHICS

Temperatures within a fusion reactor will range from the highest produced on earth to almost the lowest possible.

The problems with fission almost all stem from the smaller fragments of the original nucleus. We have no control over which of the hundreds of different fission products are formed, and, unfortunately, many are noxious, radioactive, toxic, or corrosive. These fission products are primarily responsible for the problems of reactor safety, including waste disposal and even the possibility of a meltdown.

Although fusion is conceptually simpler than fission, it is technically much more demanding. The root of the problem is that there is apparently no equivalent of the fission reaction that is induced by uncharged neutrons. All the nuclei that must be brought together for fusion are positively charged and, therefore, repel each another. This repulsive force between nuclei increases rapidly with increased atomic charge and becomes prohibitive for even moderately large atoms. Thus, it appears that fusion fuels must be chosen from among the lightest elements—hydrogen, helium, lithium, beryllium, and boron. But despite the relatively small number of light elements, more than 100 fusion reactions are possible.

Common to all is the fact that the reacting particles must be raised to very high energies (that is, must be very hot) to overcome their mutual electrical repulsion and approach close enough to fuse. Even at these very high energies, the particles are much more likely to bounce off each other at random angles—to "scatter"—than to fuse. Energy is conducted out of the system in this process. Thus, energy must be used to ignite fusion and to replace the energy continuously lost by the hot fuel. Obviously, the energy produced by the reaction must exceed the required input if the reactor is to be of any use.

But merely producing a net positive power output is not enough; achieving a high enough power *density* is also crucial. Power density refers to the rate of energy production per unit of reactor volume. Fusion will almost certainly have a lower power density than fission and therefore will require a larger plant to produce the same output. Suppose a fusion plant had to be ten times as big—and therefore likely ten times as costly—as a present-day fission plant to produce the same amount of power. Given the already intolerable costs of building fission plants, that would hardly be economically feasible. These issues of producing net energy and achieving a high enough power density are the dominant themes of fusion.

How Fusion Fuels Work

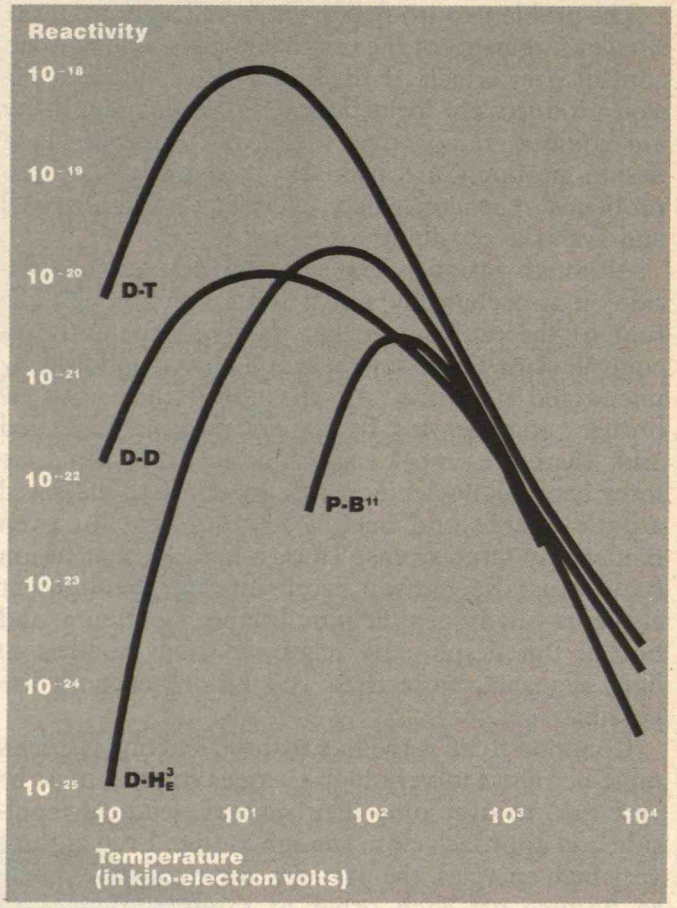
The choice of deuterium and tritium as fuels early in the fusion program evolved quite naturally. Deuterium is a nonradioactive isotope of hydrogen that, as mentioned, has one extra neutron in the nucleus. In nature approximately 1 out of every 6,500 hydrogen atoms is deuterium. Thus, it is abundant—after all, there is a lot of hydrogen in seawater—and separating it from ordinary hydrogen is straightforward because of the substantial disparity in the masses.

The first reaction seriously considered for fusion power plants was simply the self-fusion of deuterium—the D-D reaction. Deuterium reacts with itself to produce either helium-3, a stable but extremely rare isotope of helium, or tritium, the triply heavy isotope of hydrogen with two extra neutrons in the nucleus. These reaction products can themselves react with deuterium to produce even more energy than comes from the D-D reaction itself. Thus, a deuterium-fueled fusion reactor could, and almost certainly would, recycle and burn both the tritium and helium-3 in the so-called D-T and D-He^3 reactions.

Calculating the energy available from this complex series of reactions is the first problem assigned to students in my introductory course in controlled fusion at M.I.T. If they do their work properly, the students find out that the energy released by fusing the deuterium in one cubic meter of seawater equals that released by burning 2,000 barrels of crude oil. Every single cubic kilometer of ocean water therefore contains as much energy as the world's entire known oil reserves, and there are more than a billion cubic kilometers of water in the oceans. This astounding finding—in effect, an inexhaustible source of energy—shows why tens of billions of dollars have been spent and hundreds of scientists have devoted their entire careers seeking to tap this extraordinary energy source.

Unfortunately, making D-D reactions occur is extraordinarily hard, but there is an alternative. The tritium by-product that would be recycled in the D-D reactor is a far better fuel when mixed with deuterium than is deuterium itself. Not only is more energy released, but the combination of deuterium and tritium is 100 times more reactive than a simple mixture of deuterium. In other words, in similarly

The fusion of deuterium (D) with tritium (T) is 100 to 1,000 times more reactive than the fusion of combinations involving helium-3 (He^3), protons (p), or boron-11 (B^{11}). In other words, a D-T-based power plant would yield 100 to 1,000 times more energy than an identical plant using the other fuels. That is why almost all research has focused on D-T fusion. However, the energetic neutrons it releases would damage and induce radioactivity in the reactor structure.



engineered reactors, a system fueled with deuterium and tritium will produce at least 100 times as much energy as one fueled by deuterium alone. Thus, as soon as scientists realized how difficult fusion was to achieve, they almost unanimously agreed that developing the D-T reactor should be the first goal of the fusion program. This scientific goal was well justified, and no one seriously questioned it as an engineering goal at the time.

One of the first issues posed by the D-T fusion reaction was how to supply sufficient tritium. Tritium is radioactive, with a relatively short half-life of 12.4 years, and therefore it exists only in minute quantities in nature. Luckily, the neutron emitted in D-T fusion can react with an isotope of lithium to produce tritium and even release additional energy in the process. Though nothing compares with the vast store of deuterium in seawater, the world's lithium resources are enough for several thousand years of energy production. The lithium-neutron reaction resolves the tritium-supply problem. However, it introduces additional engineering difficulties.

Fusion Reactors: Large and Complex

The severity of the technical problems associated with the D-T reaction was not fully understood in the early years of the fusion program. But these difficulties have gradually been revealed by the extraordinarily detailed series of conceptual reactor designs produced under Department of Energy (DOE) funding over the last decade. The object of these studies is to describe a plausible fusion reactor based on the underlying physics and reasonable extrapolations of the technology. Of course, no one can be certain exactly what a D-T fusion reactor will look like. Nevertheless, several difficult questions that might seem to depend on this knowledge can already be answered. In particular: will a fusion reactor be simpler or more complex, cheaper or more expensive, safer or more dangerous, than a fission reactor? The answers depend only on the broad outlines of future reactors.

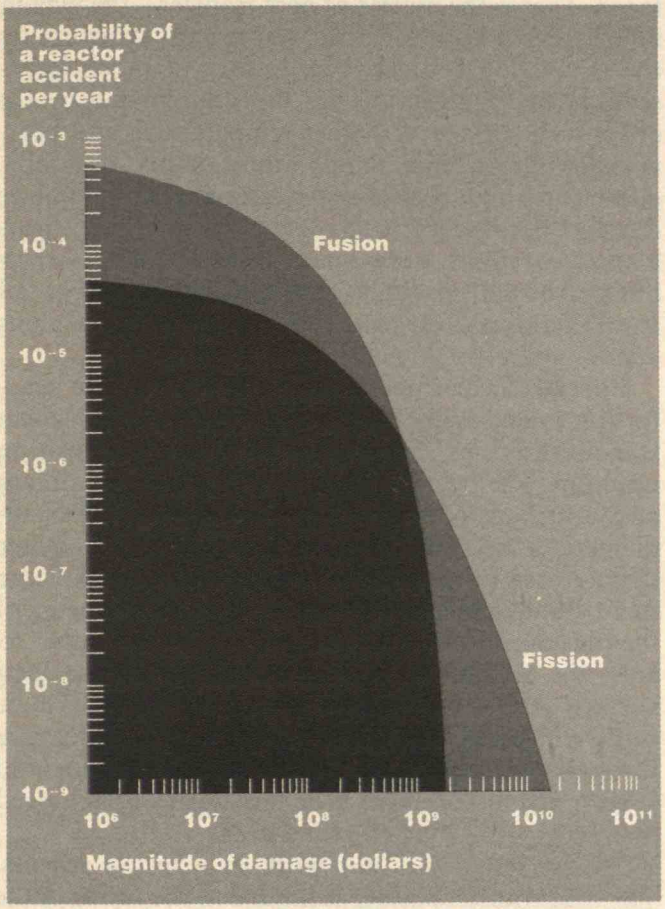
The main fusion reaction will take place in a gas-like plasma in which deuterium and tritium atoms are so energetic—so hot—that the nuclei have lost their electrons. The temperature of this gas will probably exceed 150,000,000° C. This plasma cannot be contained by physical walls, not only because no material could withstand the heat, but also because walls would contaminate the plasma. Instead, the plasma will be bottled within a vacuum by magnetic forces.

Four-fifths of the energy from the D-T reaction is released in the form of fast-moving neutrons. These neutrons are 15 to 30 times more energetic than those released in fission reactions. The first wall surrounding the plasma and vacuum region will take the brunt of both the neutron bombardment and the electromagnetic radiation from the hot plasma. This first wall is expected to be made of stainless steel or, better, one of the refractory metals such as molybdenum or vanadium that retain their strength at very high temperatures.

In colliding with this wall, the neutrons will give up some of their energy as heat. This heat must be removed by rapidly circulating coolant to prevent the wall from melting. After being piped out of the reactor, the heated coolant is used to produce steam and generate electricity.

Many of the collisions between neutrons and atoms in the first wall actually knock the atoms form-

The worst possible accident for a fusion reactor would destroy only the power plant itself—a minor hazard compared with the possibility of a meltdown in a fission reactor. However, a fusion reactor would be far more complex and prone to minor accidents. Since the fusion reactor would be too radioactive for hands-on repair, any accident could pose grave financial consequences for utilities. (The general shapes in the diagram are correct; however, the actual numerical values are uncertain and should not be taken literally.)



ing the metal out of their original positions. Each atom in the first wall will, on average, be dislodged from its lattice position about 30 times per year. Obviously, this causes the structure of the metal to deteriorate.

A few of the neutrons colliding with atoms in the first wall will have the beneficial effect of dislodging some neutrons from the atomic nuclei. These dislodged neutrons, plus the original ones generated by the fusion, pass through the wall and into the so-called "blanket," which contains lithium in some form. Here, the bulk of their energy is used to produce heat, which also is used to create steam for generating electricity, and eventually the neutrons are absorbed by the lithium to "breed" tritium.

Lithium itself poses serious engineering problems. It is an extremely reactive chemical: it burns violently when it comes in contact with either air or water and is even capable of undergoing combustion with the water contained in concrete. The lithium may be either in liquid form or in a solid compound. Liquid lithium blankets produce substantially more tritium and allow it to be more easily removed. However, the need to handle large amounts of this metal in liquid form leads to technical complexity and poses safety hazards.

The tritium-breeding region has other engineering requirements. It must be designed in such a way that the structural materials, as contrasted with the actual lithium, capture a minimum of neutrons. Also, the operating temperature must be high enough so that the coolant, when piped outside the reactor, can generate steam efficiently.

Outside the blanket, powerful magnets must provide the magnetic fields to contain the plasma. These fields will exert enormous forces on the magnets themselves, equivalent to pressures of hundreds of atmospheres. If made from copper wire, these magnets would consume more power than produced by the reactor, so they will have to be superconducting. Superconducting magnets, cooled by liquid helium to within a few degrees of absolute zero, will be extremely sensitive to heat and radiation damage. Thus, they must be effectively shielded from the heat and radiation of the plasma and blanket.

Temperatures within the fusion reactor will range from the highest produced on earth (within the plasma) to practically the lowest possible (within the magnets). The entire structure will be bombarded with neutrons that induce radiation and cause serious damage to materials. Problems associated with the inflammable lithium must be managed. Advanced materials will have to endure tremendous stress from temperature extremes and damaging neutrons. The magnetic fields will exert forces equivalent to those seen only in very high pressure chemical reactors and specialized laboratory equipment. All in all, the engineering will be extremely complex.

A working fusion reactor would also have to be very large. This conclusion is based on fundamental principles of plasma physics and fusion technology. To begin with, because of the properties of magnetic fields, a fusion reactor must be tubular. There is still dispute as to whether this tube should be bent into a toroidal (doughnut) shape, as in the device known as the "tokamak," or kept as a long, straight tube with end plugs, as in the device known as the "tandem mirror." However, the main conclusions as to the size and complexity of a D-T reactor are independent of this choice.

A fusion reactor might well produce only one-tenth as much power as a fission reactor of the same size.

The first wall of the reactor encloses the plasma. The best theories available suggest that the radius of the plasma must be at least two to three meters if the fusion reaction is to be self-sustaining. Even if a breakthrough in physics were to allow a smaller plasma, separate engineering requirements would prevent the radius of the first wall from being appreciably less than three meters. These requirements arise from the need to avoid excessive differences in power density.

For the neutrons to be slowed enough in the lithium to effectively breed tritium, the blanket surrounding the first wall must be between half a meter and one meter thick. The radiation shield outside the blanket must also be between half a meter and one meter thick to protect the supercooled magnets. Finally, the superconducting magnets and their structure will add another meter each to the radius. That gives a total radius of at least five meters for the plasma and the tube surrounding it.

In a tokamak reactor, this tube—over 30 feet across—would be bent into a doughnut-like shape at least 75 feet in outer diameter. As a power plant, this is somewhat larger than today's fission reactors and substantially more complex. If the energy density of the fusion plant turned out to be lower than that of a contemporary fission plant, as seems likely, then all this size and complexity would produce less power—hardly an economic proposition. But even if the power density were comparable, the D-T fusion reactor would, like today's fission plants, be a large and costly power source, producing thousands of megawatts of electricity. Detailed studies, some costing millions of dollars, aimed at deducing the smallest plausible size for a D-T fusion reactor all come to this same discouraging conclusion.

Such a large reactor would not meet the needs of utilities. Plagued by financially crippling cost overruns on fission reactors, managers are loathe to invest several billion dollars in any single plant, fission or fusion. Smaller plants, such as coal plants with scrubbers, are much easier to finance, not only because the investment is far lower, but also because the final cost is predictable. And if a small plant breaks down, the effects on regional electricity production are much less serious. Thus, utility managers find large plants undesirable.

Suppose fusion reactors could be built despite the inherent difficulties of size and complexity. Another critical engineering problem would still have to be faced. That is the matter of heat transfer—the way in which heat is removed from the reactor structure by the circulating coolant. The history of much large-scale power engineering has been dominated by the effort to achieve ever higher temperatures and heat-transfer rates. High temperatures imply high efficiency, and high heat-transfer rates imply high power density. Because these goals are so desirable, heat-transfer systems have been pushed close to their limits. Above these limits, materials either melt or fail from excessive stress caused by heat. Additional gains are coming only slowly.

Consider heat transfer in fission and fusion reactors. In today's typical light-water reactor (LWR), heat is generated by fission in fuel pins containing uranium. The heat is then transferred to the coolant at the surfaces of a relatively large number of small-diameter pins. This arrangement provides a larger surface area to transfer heat than, say, a single large fuel cylinder. Indeed, by decreasing the diameter of the pins even further (but increasing their number to keep the amount of uranium unchanged), the total surface area available to transfer heat would be further increased. Thus, the actual heat-transfer rate through any given square inch of surface on a fuel rod is not critical. Sufficient heat can always be removed merely by increasing the total area.

This strategy does not work in a fusion reactor. The heat-transfer surface is limited to the inside of the wall surrounding the plasma, and the relatively small surface area of this wall cannot be increased without further increasing the size of the reactor. In fact, bigger reactors need *larger* heat-transfer rates. Thus, the actual heat-transfer rate per square inch must be extremely large and cannot simply be reduced by a design change.

Suppose a fission reactor and a fusion reactor were built with equivalent heat-transfer rates. Knowing this, one can calculate two other critical engineering factors: the flux of neutrons at the heat-transfer surface, and the overall power density of the reactor. The neutron flux should, of course, be as low as possible, because it damages the reactor structure and makes it radioactive. And the power density should, as mentioned, be as high as possible, so that a reasonable amount of power will be produced in a reactor of a given size.

On these counts, a comparison between current LWR fission reactors and the somewhat optimistic fusion designs produced by the DOE studies yields a

The drawbacks of the existing fusion program will weaken the prospects for other fusion programs, no matter how wisely redirected.

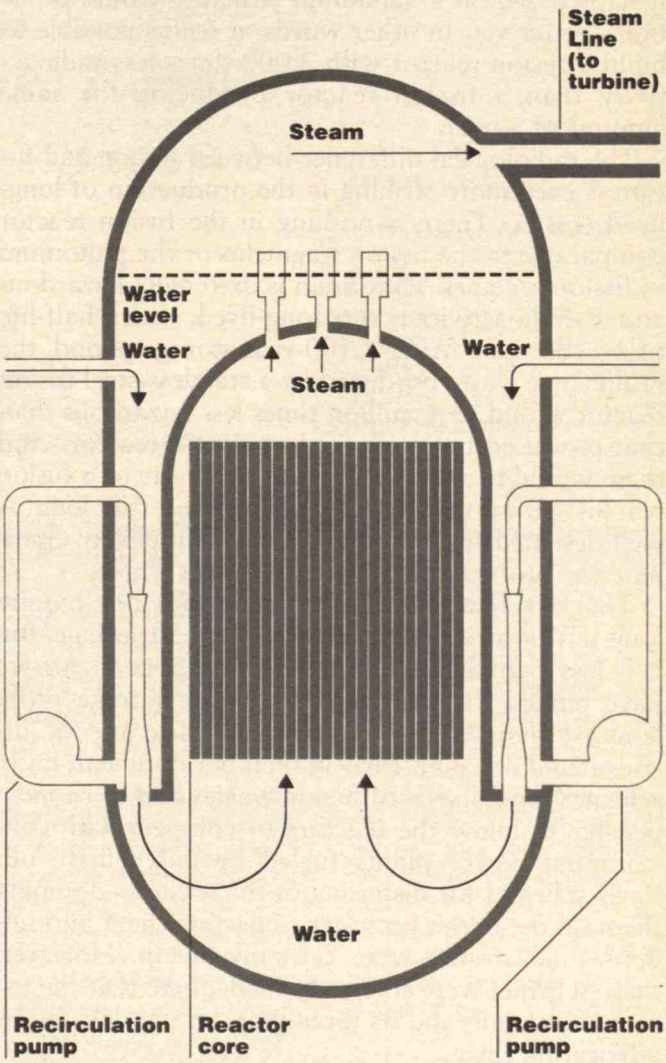
devastating critique of fusion. For equal heat-transfer rates, the critical inner wall of the fusion reactor is subject to ten times greater neutron flux than the fuel in a fission reactor. Worse, the neutrons striking the first wall of the fusion reactor are far more energetic—and thus more damaging—than those encountered by components of fission reactors. Even in fission reactors, the lifetimes of both the replaceable fuel rods and the reactor structure itself are limited because of neutron damage. And the fuel rods in a fission reactor are far easier to replace than the first wall of the fusion reactor, a major structural component.

But even though radiation damage rates and heat-transfer requirements are much more severe in a fusion reactor, the power density is only *one-tenth* as large. This is a strong indication that fusion would be substantially more expensive than fission because, to put it simply, greater effort would be required to produce less power.

Fusion's Benefits

Given all of fusion's liabilities, why are we working so hard on it? The universal availability of fuel has provided a strong motive to develop fusion, and it does promise some other substantial advantages over fission. To begin with, fusion generates much less radioactivity than fission, and there is no long-term storage problem for radioactive wastes. A fusion reactor would create a lot of tritium, which is radioactive and hard to contain. However, tritium's biological effects are relatively benign—it does not tend either to concentrate or to linger in living organisms—and it emits relatively weak radiation. After a short period of operation, the radioactivity from neutrons bombarding the structure of a fusion reactor itself would greatly exceed the feeble radioactivity of the tritium.

But even the radioactivity of the structure will be composed primarily of nonvolatile isotopes. By contrast, a substantial amount of the radioactivity in fission reactors is in the form of volatile gases that can escape if the containment structure is breeched. To further minimize the radioactivity associated with fusion, reactor designers can choose structural materials that do not become strongly radioactive when bombarded by neutrons. A fusion reactor of stainless steel would have 300 times less radioactivity than a fission reactor of the same power output. A fusion



In a fission reactor, heat from the reaction is released through the surfaces of thousands of fuel rods. Additional surface area to transfer heat can be created by providing more fuel rods but making them thinner.

However, in fusion plants, the 150,000,000° C plasma is encircled by a "first wall," the surface of which cannot be increased in any practical way. (If the encircling wall is made bigger, then the larger plasma creates even more heat.) Thus, as much energy as possible must be transferred through each square inch of the first wall. Unfortunately, improvements in heat-transfer rates are coming only slowly.

Neutrons induce radioactivity and damage reactors. Neutron-free fusion might provide inexhaustible, benign power.

reactor based on a vanadium structure would be 10 times better yet. In other words, it seems possible to build a fusion reactor with 3,000 times less radioactivity than a fission reactor producing the same amount of power.

The radiological difference between fission and fusion is even more striking in the production of long-lived wastes. There is nothing in the fusion reactor comparable to the fission fragments or the plutonium in fission reactors. Plutonium is extremely hazardous and its radioactivity is very long-lived, with a half-life of 24,100 years. After a 100-year storage period, the radioactive waste produced by a stainless-steel fusion reactor would be 1 million times less hazardous than that produced by an equivalent fission reactor. And there would be no need to store the waste of a fusion reactor with a vanadium structure even that long. A well-designed fusion reactor could completely eliminate the problem of storing long-term waste.

The fact that a fusion reactor does not require long-term waste storage seems a clear advantage. But it is less significant than would first appear, for we have tended to exaggerate the waste-storage problems of fission reactors, primarily because of ill-considered decisions early in their development. Early schemes for disposal of fission wastes had to be inexpensive to allow the reactors to compete with conventional power plants fueled by inexpensive oil. Early schemes for disposing of the wastes—dumping them on the ocean bottom or injecting them into underground strata—were certainly cheap. However, these schemes were so clearly inadequate that the fission community did its reputation lasting damage by advocating them.

Although the public is still concerned about the disposal of radioactive waste, the economic situation is now completely changed. Fission products can be safely stored, as is routinely done in Europe now. To be sure, such processes are not inexpensive. For example, one technique consists of sealing intact fuel elements in welded metallic canisters and storing them in mined granite cavities. If better techniques for storage should become available, the wastes can be retrieved. The costs of such relatively expensive disposal still play only a small role—less than 10 percent—in the total price of power. Public perception changes slowly, but the time scale under consideration is long. Waste disposal will eventually be considered a difficult but not insurmountable problem.

The matter of safety is difficult to weigh so concretely. Current analyses show that the probability of a minor mishap is relatively high in both fission and fusion plants, because both contain many complex systems. But the probability of small accidents is expected to be higher in fusion reactors. There are two reasons for this. First, fusion reactors will be much more complex devices than fission reactors. In addition to heat-transfer and control systems, they will utilize magnetic fields, high power heating systems, complex vacuum systems, and other mechanisms that have no counterpart in fission reactors. Furthermore, they will be subject to higher stresses than fission machines because of the greater neutron damage and higher temperature gradients. Minor failures seem certain to occur more frequently.

Comparing the probability of more serious accidents is harder, partly because that issue is the subject of such heated debate concerning fission reactors. But the probability of major accidents affecting public safety will certainly be substantially lower for fusion reactors. Indeed, the hypothetical worst-case accident of a fission reactor—catastrophic meltdown with release of fission products—has no equivalent in fusion. The fusion reactor simply does not contain enough radioactive material.

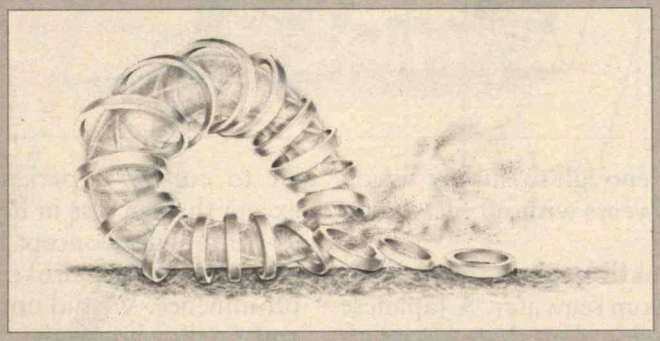
Thus, fusion reactors will have a higher probability of small accidents but a much lower probability of major accidents. This at first appears to be a strong argument for fusion, but consider Three-Mile Island. This accident, thought by some to have sounded a death knell for the fission industry, may have had equally damaging consequences for fusion. Although no one was physically injured in the TMI accident, the utility owning the reactor was mortally wounded financially. The multi-billion-dollar plant was put out of commission because it was too radioactive to repair. From a manager's standpoint, all systems that are too radioactive for hands-on maintenance are equivalent: if something major breaks, it is unrepairable. Although there is much less radioactivity in a D-T fusion reactor than in a fission reactor, it is still so high that contact maintenance would be impossible. And a D-T fusion reactor would be far more likely than a fission reactor to require repairs.

The analysis of safety factors comes down to this: While the public is primarily concerned about major catastrophes, power-plant operators are also fearful of less threatening accidents that could cause serious financial problems. In respect to these, fusion is at a

Neutron-Free Fusion

ALMOST all of the lighter elements are capable of entering into fusion reactions in which the nuclei of atoms are combined and energy is released. The prime candidates for power-producing reactions are based on two isotopes of hydrogen: protons (p), which are the standard hydrogen nuclei; and "heavy hydrogen," or deuterium (D), which has a neutron attached to the proton. The nuclei of the hydrogen isotopes have the lowest possible electric charge—one positive charge. Thus, they require lower energies to be brought together for fusion reactions than other nuclei with larger positive charges.

The original proposal for fusion was to produce power through the self-fusion of deuterium—the D-D reaction. This reaction produces, with equal probability, either the light helium isotope with two protons and a neutron (He^3) or the heaviest hydrogen isotope, tritium (T), with one proton and two neutrons. Both reactions release energy, generally measured in millions of electron volts (MeV).



$$D + D \rightarrow He^3 + n + 3.2\ MeV$$

$$D + D \rightarrow T + p + 4.0\ MeV$$

These reaction products can themselves react with deuterium and will either be "burned" in place or recycled.

$$D + T \rightarrow He^4 + n + 17.6\ MeV$$

$$D + He^3 \rightarrow He^4 + p + 18.3\ MeV$$

Because the fuel for the last two reactions is generated in the first two, only deuterium need be supplied externally. The final reaction products—ordinary helium and hydrogen—are benign, but the energetic neutrons can damage and induce radioactivity in the structure of the reactor.

Fusion based on *any* fuel cycle containing deuterium produces undesirable neutrons. The reason is this: Most of the deuterium can be made to "burn" in a desired reaction—for example, the benign D-He^3 fusion above, to produce ordinary helium, a proton, and energy. But some of the deuterium in the mixture will also collide with itself, producing neutrons and radioactive tritium; further collisions with the tritium will produce more neutrons.

Fuel cycles based on protons tend to produce far lower amounts of neutrons. The lithium-6 reaction

$$p + Li^6 \rightarrow He^3 + He^4 + 4.02\ MeV$$

is often considered because of the low charge of both constituents. But it is not completely neutron-free. A product (He^3) can react with Li^6 to produce neutrons via a low-probability, but nonetheless troublesome, side reaction.

From an engineering point of view, the boron-11 reaction

$$p + B^{11} \rightarrow 3He^4 + 8.68\ MeV$$

is nearly ideal. Neither the fuel *nor* the end products are radioactive. Furthermore, no neutrons capable of inducing radioactivity are produced.

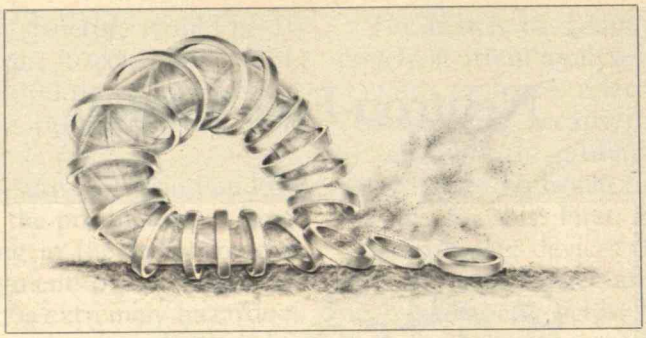
Because all the products of the boron-11 reaction are charged, they could theoretically be harnessed to generate electricity directly, without the inherent waste of generating steam to run a turbine. However, the high electric charge of boron (it has 5 protons) makes the task of designing an energy-producing system very difficult.—*L.L.*

disadvantage. If this factor is added to the reactor's high initial cost, large size, and poor power density, D-T fusion becomes an unacceptable financial risk. The public perception of fusion as ultimately safer than fission cannot nullify this.

Furthermore, in a broader sense the safety of a D-T fusion reactor would depend on its being used responsibly. One of the best ways to produce material for atomic weapons would be to put common, natural uranium or thorium in the blanket of a D-T reactor, where the fusion neutrons would soon transform it to weapons-grade material. And tritium, an unavoidable product of the reactor, is used in some hydrogen bombs. In the early years, research on D-T fusion was classified precisely because it would provide a ready source of material for weapons. Such a reactor would only abet the proliferation of nuclear weapons and could hardly be considered a wise power source to export to unstable governments.

A major driving force behind fusion has been the promise of abundant fuel. Indeed, the fusion program was originally justified not on safety grounds—

The scientific goal of the fusion program turns out to be an engineering nightmare.



fission's safety was not widely doubted then—but because of the expected rapid depletion of uranium reserves. But this is no longer a major concern. One reason is the declining demand for additional fission power and hence for the uranium to fuel it. The earth's reserves of uranium are now known to be large enough to supply fission reactors for at least 50 to 70 years without fuel reprocessing.

There has also been a breakthrough in the technology for removing uranium from seawater. A Japanese consortium is starting up a pilot plant that uses an efficient filter to trap and concentrate the extremely dilute uranium in seawater. This technology will make available virtually unlimited supplies of uranium at a cost at most ten times the current (depressed) price for conventionally mined uranium. The cost of nuclear fuel is so small a fraction of the total cost of generating electricity that the new technology would increase electricity prices only negligibly. The same oceans that could supply fusion fuels can also supply fission fuel; the abundance of deuterium for fusion ceases to be a compelling argument.

Dim Prospects for D-T Fusion

In retrospect, it is not totally surprising that fusion should fare so poorly in comparison with fission. The problem is simply that in fusion, 80 percent of the energy is released in neutrons with an energy of 14 million electron volts (MeV) that travel about 50 centimeters. In fission, less than 3 percent of the energy is released in neutrons, and these have an energy of only 1 to 2 MeV. Most of the fission products are highly charged nuclei that travel less than .001 centimeter before coming to rest.

Thus, while the major radioactivity from fission is contained within the fuel pins, the major radioactivity from fusion would damage the reactor structure and create problems of complexity, unreliability, and size. While fission's numerous wastes pose problems of disposal and reactor safety, fusion's neutrons could easily be used to manufacture material for atomic weapons. It is hard to see why a utility in need of additional generating capacity would purchase a D-T fusion reactor instead of a contemporary LWR fission reactor. And as far as most utilities are concerned, even the LWR no longer seems a good choice.

The early history of the fission program was similar to current experience in the fusion program—except that success in fission came too easily. As soon as we found a concept that worked reasonably well, powerful forces drove that machine, the LWR, to prominence. We did not take the time to test, modify, and finally choose the "best" nuclear reactor among many competitors.

Now we know that safer, smaller, and probably cheaper fission reactors can be built. In fact, reactors could be small enough to be assembled in a factory and shipped via truck, reactors so safe that no operator error or even loss-of-coolant accident could cause release of radiation. The dreaded meltdown would also be impossible in these small, "modular" reactors. Such a reactor has been operating for 15 years in Germany. To be sure, this kind of reactor would probably not be the best choice in a world in which uranium was scarce and reprocessing and fuel breeding were necessary. But we do not live in such a world. Unfortunately, the resounding crash of the LWR has prejudiced the possibility of a new beginning for fission reactors.

The only real hope for fusion is to take the long view ignored in the fission program. Neutron-free fusion is a quintessential example of a high-risk, high-gain area of physics that *might* also provide a good answer to an engineering problem. We have no guarantee that an answer exists. But we know that if it does, it can meet the original goal of the fusion program—universally available, inexhaustible, environmentally benign power. Perhaps we should not be greatly troubled that our first attempt to develop such a marvelous thing will not be the success we had hoped. We can go on to seek a better alternative.

LAWRENCE M. LIDSKY, professor of nuclear engineering at M.I.T., is an associate director of the Plasma Fusion Center and editor of the Journal of Fusion Energy. *He has worked on plasma physics and fusion-reactor technology for 20 years.*

MIT

Windsurfing on the Charles: Off—and Then On Again. See page A2

The cover—Windsurfing
Just as it was gaining a big following among members of the M.I.T. Nautical Association, windsurfing lost its momentum in mid-August: the Metropolitan District Commission, which runs the Charles River Basin, banned the sport; then relented—a special dispensation for M.I.T., whose sailboarders are so well trained that they hardly ever fall in. (Photo: Peter Mui, '82)

The stuff of reunions: C. George Dandrow, '22, greets Carole A. Clarke, '21 (left) at the Technology Day luncheon on June 10. Dandrow was Alumni Association president in 1948-49, Clarke secretary of his class from 1921 to 1971. (Photo: Scott Globus, '84)

Can It Be Quiet When 2,100 Alumni Return and Renew?

It Was, and They Did—with an "Awesome" Display of Support

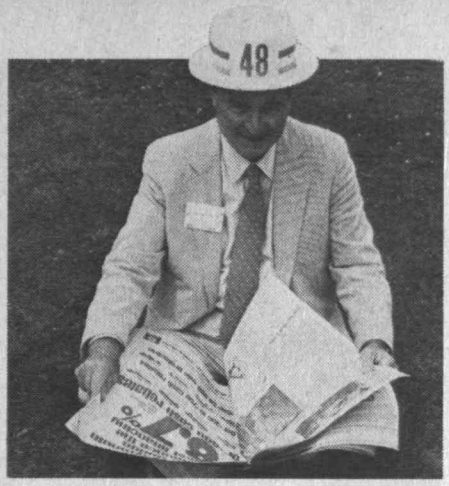
At Princeton they loose a tiger in the streets. At Harvard they listen to orations by learned scholars. It's quieter at M.I.T. when alumni return to share the nostalgia, friendships, and stimulation of a reunion in the familiar halls. And this year, when just over 2,100 turned out for the Technology-Day-and-reunions weekend, it was clear that good fellowship need not be boisterous, not even athletic. Nearly all of the 14 reunions were quieter than usual: a relaxed and relaxing mood prevailed nearly everywhere.

The notable exception was the indefatigable Class of 1928, whose 155 members and guests sampled the John F. Kennedy Library, Hawthorne-by-the-Sea, the Boston Museum of Science, and several Institute destinations in a five-day marathon that started with registration on June 8 and ended with a brunch on June 12. The spirit of that lively group was typified by two contributions to its *Thoughts and Sentiments* book: "To exist is to change; to change is to mature; and to mature is to create oneself endlessly," wrote Alexander Daytz. And William I. Bendz' greatest wish, as he watched his grandson's fingers flying over the keyboard of an Apple computer: "If only I could become a member of the M.I.T. Class of 2028!"

Another break with tradition: a two-day reunion program organized chiefly by Max Seltzer, '18, for his classmates and *all* those of older classes—that is, 65 or more years graduated. A remarkable 34 alumni and guests were on hand for a program that ranged from a seminar with economist Professor Lester D. Thurow to a formal dinner at the 225 Club atop the State Street Bank and Trust Building in Boston.

Interfacing with Artificial Intelligence and E.T.

All those returning shared four major events—"Tech Night at the Pops" on June 9; and a special lecture series on artificial intelligence—how computers can be made to seem intelligent and what will be the implications—the annual memorial service, and the Technology Day luncheon on June 10. In



Among those present (counterclockwise from the left): A. Graham Sterling, '48, with his *New York Times:* Wilfred Kaneb, '43 (left) with classmate James Hoey; Vincent James, '78; Hans Scharer, '58, and Juliette Noble; and Robert T. Dawes, '26, and Mrs. Dawes. (Photos: Scott Globus, '84)

addition there were departmental open houses on Friday afternoon.

Pops maestro John Williams had his audience literally in his palm as he led excerpts from his score to *E.T. (The Extra-Terrestrial)* and as he accompanied on a cembalo (harpsicord, to most of us) four violinists and members of the Pops' string section in Vivaldi's B-Minor Concerto.

Understanding artificial intelligence the next morning turned out to be a tougher assignment—but the challenge drew more than 1,000 to Kresge Auditorium. Why so tough? Consider, said Arnold Kraft of Digital Equipment's Intelligent System Technologies Group: the human brain contains 100 billion neurons, each with 2,000 interconnections, the whole served by 100 billion nerve channels. "A hard act for a computer to follow," he said.

The real problem may be less logic than language, said Professor Wendy G. Lehnert of the University of Massachusetts (Amherst). It is one thing to turn a problem over to a computer that is supposed—all on its own—to find the answer. It is quite another for the user to have

The talent behind Technology Day included Lois Champy, M.Arch.'72, chairman of the committee, and Joseph J. Martori, associate secretary of the Alumni Association.

A salute to Marty Billett, '48—a Lobdell Award of the Alumni Association for his many services to his class—presented by Shirley A. Picardi, Ph.D.'76, secretary of the Alumni Association, during class reunion activities at the Chatham Bars Inn on June 11.

confidence in the computer—and its answer—if the computer cannot tell what it is doing and what it is finding in plain English. In AI jargon, said Professor Lehnert, we need better "natural language interfaces."

A Balloon from the Underground

It was easier to understand the morning's surprise, when a six-foot rubber balloon gradually emerged from the Kresge lawn. It was a reenactment of the startling Harvard Stadium "hack" perpetrated during the Harvard-Yale game of last fall by members of Delta Kappa Epsilon at M.I.T. (*see January, p. A10, and February/March, pp. A4-A5*). Despite President Paul E. Gray's protestations to President Derek Bok of Harvard, the DKE's device had been in Harvard's hands until sometime during the spring; it was liberated through an undisclosed "underground retrieval system" alleged to have involved the M.I.T. Campus Patrol. (The device is now safely in the permanent custody of Warren A. Seamans, director of the M.I.T. Museum.)

During the annual Technology Day luncheon the major reunion classes announced gifts to the Institute of more than $13.8 million (including a near-record $3.65 million from the Class of 1933)—an "awesome" total, said President Gray, "a record of marvelous support of M.I.T. by its sons and daughters."

The luncheon brought together 1,200 alumni from 75 classes—the oldest being two representatives from the Class of 1908, Harold S. Osborn and Franklin T. Towle. Professor Shikao Ikehara, '28, of Tokyo had come farthest to be present.

There were honorary memberships in the Alumni Association for three members of the Institute staff who have taken vital roles in alumni activities—D. Hugh Darden, assistant treasurer for planned gifts and legal affairs; Julia C. McLellan, senior associate director of admissions; and Salvatore Lauricella, who has served alumni countless meals as manager of special functions in the M.I.T. Dining Service. And there was a special tribute—a Steuben beaver—for Howard W. Johnson, who retired as chairman of the Corporation on July 1.

Reunion highlights. This page, counterclockwise: a gift of thanks for Stephanos Hadjiyannis, reunion treasurer, from Martin O'Donnell for the Class of 1958; Howard W. Johnson leads a bus-bound chorus en route to Symphony Hall; and the re-enactment of Delta Kappa Epsilon's Harvard Stadium hack of November 1982.

Finally, President Denman K. McNear, '48, surrendered his gavel symbolic of the Alumni Association presidency to his successor, Professor Robert W. Mann, '50, the first president to be chosen from the ranks of the faculty since Professor Samuel C. Prescott, '94, served in 1927-28. That distinction appeals to him, said Professor Mann: "We faculty turn students into alumni," he told the luncheon audience, and he wants to draw on that experience "to strengthen the relationships between alumni and alumni-to-be." He's relinquishing teaching responsibilities for the year in order to have more time for Alumni Association assignments.

Alumni Gifts: "We Need You and Count on You"

Reunion gifts totalling more than $13.8 million were reported at the Technology Day luncheon on Friday, June 10. The major presentations:

☐ A 50th reunion gift from the Class of 1933 of $3,650,775, presented by Dayton H. Clewell, chairman of the gift committee. It was the second largest 50-year gift in M.I.T.'s history from a total of over 560 alumni—55 percent of the class. In addition, said Mr. Clewell, more than 20 members of the class were known to have made plans for bequests to the Institute totalling at least $2.6 million.

☐ From the 40-year Class of 1943 by Stanley M. Proctor, gift committee chairman: a record-breaking $2,288,455. No 40-year class has ever done so well before, he said, in expressing its "love and respect for the institution from which we have received so much sustenance." Of the total, over $500,000 is endowment for a professorship.

☐ From the 25-year class of 1958, a gift of $702,407 in which 57 percent of the class participated. Just under half of the total was designated as endowment for a professorship, said Joseph J. Gal, gift committee chairman.

☐ An unprecedented 60-year $7.2 million gift from the Class of 1923. No 60-year class has ever attempted such a gift before, said Denman K. McNear, '48, president of the Alumni Association.

☐ A gift of $21,000 from the five-year Class of 1978, the result of participation by 50 percent of the class, according to David A. Woodruff, gift chairman. Included was more than $8,700 for a student aid fund that is pledged to reach $50,000 by 1988, when the group returns for a 10th reunion. Of special note, said Mr. Woodruff, is the fact that 73 percent of the class has contributed at least once to the Alumni Fund since graduation. That figure is reached by most classes only after at least 10 years, according to Joseph J. Collins, director of the Alumni Fund.

☐ From the newest M.I.T. class—1983—a senior gift of $4,349. Matched by members of the Class of 1933, the new fund, reported by Kenneth E. Dumas, president, will establish the Jerome B. Wiesner Student Art Gallery.

To this outpouring, President Gray responded with "deepest appreciation. The foundation of M.I.T.'s excellence is the support of alumni," he said. "We need you and count on you."

More than 550 undergraduates were among those who found the joy and satisfaction of talking with fellow-alumni about M.I.T. at 1983 Alumni Fund telethons.

Alumni Fund at $8.6 Million and 50 Percent; but "You Never Can Win"

More alumni gave more through the 1983 Alumni Fund than in any previous year—a total of $8,662,000. The gifts came from 26,811 contributors—also a new record that took undergraduate alumni participation in the fund to the 50-percent mark for the first time in history.

Joseph S. Collins, director of the fund, calls that 50-percent mark "the four-minute mile of alumni funds"—perhaps the most significant of a number of records broken in 1983. It means that over half of all the living alumni who hold undergraduate degrees from M.I.T. are now taking steps to repay what President Paul E. Gray, '54, calls the "hidden scholarship" that each received as a student—the difference between the total cost of an M.I.T. education and the tuition each student pays.

Among other records set in 1982-83:

☐ 33 percent of alumni with graduate degrees from M.I.T. contributed in 1983.

☐ Nearly 7,300 of the gifts received in 1983—more than a quarter of all giving—topped $100, and 2,661 alumni gave $250 or more.

☐ Telethons—gift solicitation by telephone—accounted for $585,000 pledged to the 1983 Alumni Fund. A total of 1,248 callers, including 566 undergraduate students, reached 17,087 alumni—28 percent of the entire alumni population.

☐ The numbers of Great Dome Associates and Sustaining Fellows both increased in 1982-83. A notable increase in the former brought the total of Great Dome Associates to 2,100—up 55 percent in two years.

☐ Corporate matching gifts, benefitting from the leverage of the other records set in 1983, reached $1.2 million, up 18 percent over 1982.

Reporting these results to President Paul E. Gray, '54, James K. Littwitz, '42, chairman of the 1983 Alumni Fund Board, called attention to the five-year record of the fund from 1978 to 1983: a 29 percent increase in participation and average annual increases in giving of $700,000. Such figures, said Littwitz, clearly show "an understanding of the needs of the Institution.

"We pledge you our continuing support," he told President Gray.

Dr. Gray responded with a statement of thanks for the entire Institute: "All of us who carry out the day-to-day tasks involved in preserving and improving this special place are greatly encouraged," he wrote Littwitz. And especially, said Dr. Gray, he is impressed by "the commitment of time on behalf of the fund made by hundreds of alumni and alumnae. All of us are most grateful and appreciative."

David S. Saxon, '41, newly arrived at the Institute as chairman of the Corporation, told Alumni Fund workers early in August that he shared their sense of pride. "But you never can win at this game," he warned Mr. Collins and his associates: "you have to do even better next year."

M.I.T. Sustaining Fellows as of June 30, 1983

The M.I.T. Sustaining Fellows program was established in 1979 to recognize individuals whose support of the Institute is particularly exemplary. Sustaining Fellows membership is extended to alumni and other friends of M.I.T. making annual gifts of $2,000 or more for unrestricted purposes, endowment, professorships, or student aid; life membership is offered to donors whose cumulative gifts exceed $25,000. Donors requesting anonymity are not shown.

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Mr. and Mrs. Harold S. Osborne*

1912
Dr. Jerome C. Hunsaker*

1913
Mr. Julian E. Adler*

1914
Mrs. Vashti L. Magoon*

1915
Mr. C. Ellis Ellicott*
Mrs. Edmund R. Stearns*
Mr. Robert Welles*

1916
Mrs. Thomas D'Arcy Brophy*
Mrs. J. B. Carr*
Mr. Barnett D. Gordon*
Mrs. Francis E. Stern*

1917
Mr. and Mrs. Walter J. Beadle*
Mr. A. Raymond Brooks*
Mr. E. P. Brooks*
Mrs. Stanley M. Lane*
Mrs. Richard T. Lyons
Mrs. William H. McAdams*

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Mrs. John W. Kilduff*
Mr. and Mrs. Max Seltzer
Dr. and Mrs. Harold C. Weber

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Mr. and Mrs. Royden L. Burbank*
Mr. John L. Riegel*
Mrs. Dean K. Webster, Jr.*

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Mr. Henry W. Hills*
Mr. and Mrs. Edwin D. Ryer*
Mr. L. G. L. Thomas*

1921
Mr. Wallace T. Adams
Mr. T. B. Davis*
Mr. Sumner Hayward
Mr. Irving D. Jakobson*
Mr. Samuel E. Lunden*
Mr. and Mrs. Edmund J. MacDonald
Mr. Robert L. Moore*
Mr. and Mrs. Antonio Helier Rodriguez*
Mrs. Raymond A. St. Laurent*
Mrs. Arthur G. Wakeman*
Mr. and Mrs. Robert E. Waterman

1922
Mr. and Mrs. Edward L. Bowles*
Mr. Donald F. Carpenter*
Mr. Whitworth Ferguson*
Mr. Crawford H. Greenewalt*
Mr. Oscar H. and Mrs. Mary C. Horovitz*
Mr. and Mrs. Albert J. R. Houston*
Mr. H. W. and Mrs. S. Catharine McCurdy*
Mr. Theodore T. Miller*
Miss Marjorie Pierce
Mr. and Mrs. Thomas H. West*

1923
Mr. and Mrs. Jonathan Y. Ballard*
Mrs. Philip L. Coleman*
Dr. and Mrs. Cecil H. Green*
Mr. Earle A. Griswold*
Mr. and Mrs. Harry Kalker
Mr. Ragnar D. and Mrs. Margaret Naess*
Mr. Alfred E. Perlman*
Mrs. David W. Skinner*
Mr. and Mrs. Robert C. Sprague*
Dr. and Mrs. Julius A. Stratton*
Mr. Chaplin Tyler

1924
Mr. and Mrs. Edward A. Abdun-Nur
Mr. Gordon Y. Billard*
Mr. and Mrs. Philip D. Blanchard*
Mr. and Mrs. Austin G. Cooley*
The Honorable Luis A. Ferre*
Mrs. Edward J. Hanley*
Mrs. Harold L. Hazen*
Mrs. Andrew P. Kellogg*
Mr. Paul Tishman*

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Mr. Edward H. deConingh
Mr. and Mrs. Frederick W. Greer*
Mr. Edward M. Lee
Mr. and Mrs. Samuel R. Spiker*
Mr. and Mrs. Karl R. Van Tassel*
Mr. and Mrs. C. L. Zakhartchenko

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Mr. and Mrs. Robert T. Dawes*
Mr. and Mrs. William E. P. Doelger*
Mr. George P. Edmonds*
Mr. and Mrs. Eben B. Haskell*
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Mr. and Mrs. George J. Leness*
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Prof. and Mrs. Gifford H. Symonds
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Mr. and Mrs. John B. Wright*

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Mr. Arthur J. Connell*
Mr. and Mrs. Arthur G. Connolly
Dr. and Mrs. Harold E. Edgerton
Mr. and Mrs. Harold W. Fisher*
Mr. B. Allison Gillies
Mr. William Kaplan
Mr. and Mrs. Thomas A. Knowles
Mr. John W. Norris, Sr.*
Mr. Howard W. Page*
Mr. Russell P. Westerhoff*
Mr. and Mrs. Clarence L. Wynd*

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Mr. and Mrs. Roland D. Earle
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Mr. Elisha Gray II*
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Mr. Carl M. Loeb, Jr.*
Mrs. Edward J. Poitras*
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Mr. and Mrs. Abraham Woolf*

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Mr. and Mrs. Dexter T. Osgood*
Mr. John J. Wilson*

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Dr. Walter W. Soroka*
Mr. and Mrs. Richard M. Wilson
Prof. Ching T. Yang*

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Mr. and Mrs. Emilio G. Collado*
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Mrs. James B. Fisk*
Dr. and Mrs. Norman D. FitzGerald
Mr. and Mrs. Kenneth J. Germeshausen*
Mr. J. K. Jamieson*
Mr. and Mrs. Claude F. Machen*
Mr. and Mrs. Howard L. Richardson
Dr. and Mrs. Donald B. Sinclair*
Mr. Harold M. Wilson

1932
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Mr. and Mrs. Wendell E. Bearce
Mr. Cecil Boling*
Mr. Donald W. Brookfield
Mr. and Mrs. Howard F. Carver
Mr. and Mrs. Alexander D. Daunis*
Mr. Gaynor H. Langsdorf
Mr. John Navas*
Mr. and Mrs. Eric P. Newman*
Mr. Robert B. Semple*
Mr. and Mrs. Richard M. Stewart

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Mr. Ralph and Mrs. Eloise Cross*
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Mr. and Mrs. G. Russell Eddy
Mr. Herbert E. Grier*
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Mr. Warren J. Henderson*
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Mr. and Mrs. C. D. Marshall*
Mr. and Mrs. Malvin J. Mayer*
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Mr. Frederick V. Murphy, Jr.*
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Dr. and Mrs. John Sterner
Mr. and Mrs. Harris A. Thompson
Mr. James E. Turner*

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Mr. and Mrs. Albert A. Hopeman Jr.
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Mr. William H. Mills*
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Mr. and Mrs. Louis E. Stahl*

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Mrs. Quentin Berg
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Mr. George S. DeArment*
Mr. James M. Ewell*
Mr. and Mrs. Herbert F. Goodwin*
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Mr. Joseph F. Keithley*
Mr. and Mrs. William J. McCune, Jr.*
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1938
Mr. Peter de Florez
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Mr. James C. Longwell
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1939
Mr. William S. Brewster
Mr. Leonard Mautner*
Mr. and Mrs. Harold J. Muckley*
Mr. and Mrs. Harold R. Seykota*

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Mr. W. H. Krome George
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Mr. Floyd A. Lyon*
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Mr. Edward L. Pepper
Mr. and Mrs. Edward O. Vetter*
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Mr. and Mrs. Stanley M. Proctor*
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1944
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Mr. and Mrs. James Simons
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Dr. William I. Koch*

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Mr. Charles Ying*

1968
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Mr. Richard Ying*

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Dr. and Mrs. Robert Seamans, Jr. '42*

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Mr. Robert C. Gunness '34*
Mr. John C. Haas '42*
Mr. C. J. Harrington '38*
Dr. and Mrs. Frederic Holloway '39
Dr. and Mrs. Ralph Landau '41*
Mr. Jan W. Mares '60*
Mr. Charles B. McCoy '32*
Mr. Ralph D. Patch '32*
Dr. Charles E. Reed '37*
Mr. and Mrs. William C. Rousseau '36
Dr. Arch C. Scurlock '43*
Mr. George R. Vila '33*

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Dr. Robert G. and Mrs. Alma S. Breckenridge '42*
Mr. Edward R. Kane '43*
Dr. Howard S. Turner '36*

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Dr. and Mrs. Louis Berger '40*

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Mrs. Henry W. Gadsden*
Mr. Robert W. Galvin*
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Ms. Marion Hanny*
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Mr. and Mrs. J.E. Jonsson*
The Aga Khan*
Mr. Max and Mrs. Betty Kranzberg*
Mr. and Mrs. William S. Lasdon*
Mr. Albert and Mrs. Vera List
Mr. Edmund W. Littlefield*
Miss Gladys F. MacDonald
Mr. Henry J. McCarthy*
Mrs. Eugene M. McDermott*
Mr. J. Irwin Miller*
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Mr. and Mrs. W.B. Murphy*
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Mr. Nick F. Badami*
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Mr. and Mrs. Frank E. Heart
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Mr. William L. Maini
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Mr. Irwin J. Grossman*
Mr. J. Burgess Jamieson
Mr. and Mrs. James R. Reese*
Mr. and Mrs. John S. Rydz

1953
Mr. Gunther W. Balz*
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1954
Mr. Robert H. Brown, Jr.*
Mr. Paul E. and Mrs. Priscilla K. Gray*

1955
Mr. John Buchanan Brown*
Mr. Gerald Cohen
Mr. George P. Edmonds, Jr.*
Dr. and Mrs. Russell G. Meyerand, Jr.*
Mr. DuWayne J. Peterson, Jr.*
Mr. James W. Storey*

1956
Mr. Edwin H. Baker
Mr. R. Gordon Black
Mr. Roger and Mrs. Brenda Borovoy*
Mr. Dimitri A. Manthos
Mr. Regis W. Schultis, Jr.
Mr. Jerome E. Vielehr
Mr. and Mrs. Harris Weinstein

1957
Mr. Joseph Cohn
Mr. Harry B. Duane*
Mr. Jordan L. Gruzen
Mr. Edward L. Hoyt
Mr. Elliot K. Wolk

1958
Dr. Robert W. Hausslein
Mr. Robert E. Jordan, III
Mr. Stanley and Mrs. Bonnie Klein
Mr. Sanford M. Nobel*
Mr. Martin J. O'Donnell
Dr. Conrad S. Revak
Mr. Glenn P. Strehle
Mr. and Mrs. Emil Wright, Jr.

1959
Mr. H. H. Champlin
Mr. Terry L. Gildea
Mr. David J. McGrath, Jr.*
Mr. Carlos Prieto
Dr. Lawrence G. Roberts
Mr. Robert A. Schumacker
Mr. Joseph D. Zimmerman

1961
Mr. Richard B. Slifka*

1962
Mr. and Mrs. Richard J. Clayton
Mr. Edward H. Linde
Mr. Vijay J. Shah
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1963
Mr. John K. Castle*
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1964
Mr. Robert L. Blumberg

1965
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1967
Mr. David Griffel

1970
Mr. Charles L. Housman*

1971
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Mr. Robert L. Mitchell '47*
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Mr. and Mrs. C. K. Walker '40

Chemistry
Dr. John E. Wood III '39

Civil Engineering
Dr. Ernest Basler '57*
Dr. Roy W. Carlson '39
Mr. Robert L. Daniels '66

Electrical Engineering
Dr. Edward E. David, Jr. '47
Dr. Jerrold Heller '64
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Dr. and Mrs. M. E. Shank '49*

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Mr. V. K. Atkins '47
Mr. Guy and Mrs. Francoise Viellet '50

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1920
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Leander H. Poor
Edward C. Rue
Joseph H. Scholtz, Jr.
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Allen W. Hawkins
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Donald E. Moore
Wilmot G. Peirce, Jr.
Herbert R. Stewart
Willard W. Van Allen
Luang Videt-Yontrakich
John H. Walthall

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Willard C. Asbury
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L. Patterson Elliott
F. Leroy Foster
Arthur G. Hall
Maxon H. King
Russell C. Mader
James W. McGuire
Max M. Sandfield
Gilbert P. Tarleton
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Courtenay P. Worthington

1926
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Irl Sandidge, Jr.
Charles A. Southwick, Jr.
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Eric A. Bianchi
Karnig S. Dinjian
Arnold W. Ewan
Hyman J. Fine
Ogden Fitzsimons
Alfred H. Hayes
William H. Lerner
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E. Gunnar Peterson
James C. Reddig
Hunter Rouse
Louis F. Southerland, Jr.
Thomas H. Speller
Edward D. Thomas
Ralph Vezin
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Benjamin C. Buerk
Homer L. Davis, Jr.
Bartholomeo DeLorenzo
William C. Dickerman, Jr.
Earl E. Ferguson
Howard S. Gardner
Joseph Harrington, Jr.
Maurice S. Herbert
Philetus H. Holt
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Myron Leedy
Leroy F. Marek
Hugh J. Mulvey
Theodore A. Riehl
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C. Haskell Small
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1931
Charles Broder
Christopher John Chamales
John H. Dodge
Arthur G. Fuller
William J. Hallahan
Clement H. Hamblet
A. Hesselschwerdt, Jr.
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Edward B. Hubbard
John G. B. Hutchins
William C. Kay
Stuart R. Knapp
Robert G. Marcus
Carrington Mason
Joseph P. McBrien
Arthur T. Newell
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Myrle M. Perkins
John R. Swanton, Jr.
Kenneth E. Wischmeyer

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Edward F. Cahoon
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Albert W. Dunning
Eugene F. Lynch
J. Alan MacDonnell
Willis M. Moore, Jr.
Archie Riskin
James G. Ritchey
Joseph Santoro
Thomas R. Smith
Charles H. Taylor
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William E. Barbour, Jr.
Morris C. Beldon
George P. Bentley
Joshua A. Bregman
George R. Churchill
Morris Cohen
Warren S. Daniels
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George F. Garcelon
Ivan A. Getting
Frank F. Gilmore
Roland D. Glenn
Arthur S. Hayden
George E. Hughes
Wilber B. Huston
Charles Keller, Jr.
William B. Klee
Lennox H. Lindsay
Prentiss Lobdell
Horace K. MacKechnie
Hollinshead T. Martin
Maxwell D. Millard
V. Lawrence Parsegian
Paul J. Petitmermet
Frederick D. Petrie
Otto A. Putnam
Richard Robinson
George H. Ropes
Lincoln W. Ryder
John R. Sloat
David B. Smith
Richard B. Smith
Joel B. Stevens, Jr.
George A. Stoll
Robert W. Timbie
Julio C. Ulloa
Francis B. Vaughan
Olavi Viita
Stanley H. Walters
Warren G. Webster
Beaumert H. Whitton

1934
Gerhard Ansel
Charles W. Bechle
Robert C. Becker
John J. M. Carey
Edgar B. Chiswell, Jr.
Roger T. Coffey
Joseph Fishman
Edward S. Fleming
Robert M. Franklin
George Irvin Gahm
Frederick C. Johnson
H. Neal Karr
Robert L. Kenngott
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James E. Castle
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Albert F. Sanderson, Jr.
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David D. Terwilliger
Shea L. Valley
Frank S. Walters
Kasmierz J. Winiarski

1936
Kenneth J. Arnold
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Edward L. Brewster
Robert J. Caldwell
Bernard J. Cosman
Kathleen V. Cummins
Richard A. Denton
Dana Devereux
Harry E. Essley
Richard B. Fox
Lewis Gelbert
Robert S. Gillette
Martin A. Gilman
Eli A. Grossman
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Harold F. Miller
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George S. Trimble
Roman I. Ulans

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Wells Coleman
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Vanburen N. Hansford
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Jerome E. Salny
James H. Schipper
Joseph A. Smedile
Harry J. Sommer
Walter S. Wojtczak
William C. Wold
Duane O. Wood
Albert S. Wynot
Stanley D. Zemansky

1938
Franklin S. Atwater
Louis Bachmann
Howard Banzett
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G. Edwin Hadley
Roy C. Hopgood
Harold James
Solomon Kaufman
Walter F. Kaufman
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Frederick J. Kolb, Jr.
James Maguire
Paul O'Connell
Frederick E. Ray
Harry O. Saunders
D. Sinclair Scott
Philip E. Sellers
Tseng Y. Shen
David R. Wadleigh
George B. Wood

1939
Philip D. Bush
George W. Cannon, Jr.
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John H. Crankshaw
H. King Cummings
William A. Davis
Charles F. Freyfogle
Frederick B. Grant
Michael V. Herasimchuk
John I. Herlihy
Benjamin T. Howes
Burkhart A. Kleinhofer
B. Leonard Krause
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George P. Morrison
William A. Murphy, Jr.
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W. Hewitt Phillips
Gordon A. Pope
Harold W. Pope
Samuel Sensiper
Edwin M. Tatman
Irwin K. Weiss
Theodore Wroblewski

1940
Paul V. Bollerman
Harvey H. Brown
Richard P. Dickson
N. Bruce Duffett
Richard J. Eberle
James E. Fifield
Harold Graham
Joseph H. Greenberg
Edward G. Hellier
Joseph C. Jefferds, Jr.
Frederick Lange
David F. Lowry
Rafael J. Martinez
Marshall D. McCuen
Robert G. Millar
Franklin E. Penn
Samuel Rabinowitz
Schrade F. Radtke
H. Francis Sparks
Philip A. Stoddard
Ralph N. Thompson
M. Spalding Toon
John A. Vanderpoel
L. D. Wheaton
George M. Wolfe
William S. Woodward
Alfred C. Wu

1941
Robert E. Bailey
Robert Wallace Blake
Merlyn J. Block
Roger G. Blum
Albert H. Bowker
George S. Burr
William T. Butt
Ivor W. Collins, Jr.
Joseph E. Dietzgen
Martin L. Ernst
Robert M. Fano
Lewis D. Fykse
Sanford E. Glick
Rudolph W. Hensel
Sterling H. Ivison, Jr.
William E. Lamar
Philip S. Lewis, Jr.
Robert A. Mallory
James W. Mar
David S. McNally
Harold Raddiffe
John F. Sexton
Robert E. Smith
Frederick H. Thompson

1942
Arthur W. Avent
Lawrence E. Beckley
Charles E. Bossi
Curtis D. Buford
Luther Davis, Jr.
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Robert J. Fay
Richard X. Gannon
Robert H. Given
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Robert T. Howard, Jr.
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Joseph R. McHugh
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Ward J. Haas
Charles A. Hathaway
Richard E. Henning
Bedrich V. Hettich

continued on page A20

Five months after 46 graduate women moved into what had been M.I.T.'s infirmary at 350 Memorial Drive, the newest house was given its name: Ida Flansburgh Green Hall. Celebrating on June 10 are the honoree and (left to right) her husband, Cecil H. Green, '23; President Paul E. Gray, '54, and Howard W. Johnson, chairman of the Corporation. (Photo: Calvin Campbell)

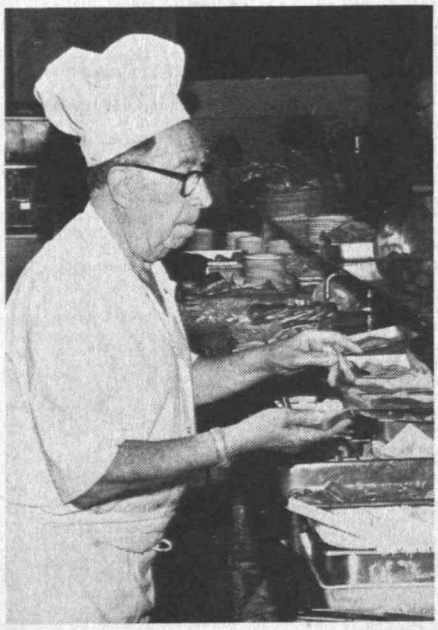
A New House for 46 Graduate Women Takes Ida Green's Name

Ida Flansburgh Green came to know M.I.T. because her husband, Cecil H. Green, '23, knew it so well. But by now there is nothing second-hand about Ida Green's support and loyalty for her husband's *alma mater*. In addition to joining him in supporting countless Institute projects, Ida has been a champion of women at M.I.T. Her name is given to a series of fellowships for graduate women, and now it also appears on Memorial Drive over the entrance to M.I.T.'s first residence for women graduate students.

In its earlier guises, the building at 350 Memorial Drive was successively a doctor's office/residence, a hospital, and M.I.T.'s infirmary. But on June 10, 1983 it became Ida Flansburgh Green Hall—M.I.T.'s first residence reserved for women graduate students. By then the $1 million remodelling from hospital to residence was five months old, and Andra E. Smith, a graduate student in materials science, was able to report to Mrs. Green that she and her student colleagues were "absolutely overjoyed to be able to live there" during the spring term. "It's wonderful to see a cohesive group of graduate women at M.I.T.," she said—too often the pressures of graduate work mean isolation and loneliness.

At the dedication ceremonies Mrs. Green said that never had the naming of a new university building given her more pleasure. "What excites me most," she said, "are the people who live here—and what they will do in the next 50 years."

The erstwhile infirmary has been completely renovated to provide housing for 46 women students—30 singles and 8 double rooms. There are also four kitchen/lounges, a suite for a faculty resident, and other common facilities, including laundry.



Nobody—and least of all Joe Di Napoli—tried to guess the number of sandwiches he made in 43 years of working in M.I.T. dining halls; one time-and-motion study put his prowess at 75 an hour. But it's all over now; Joe retired on June 30 to a life of leisure, in which one sandwich a day may be enough. (Photo: Calvin Campbell)

1,075 Frosh Expected

As their arrival date approached late in the summer, the Class of 1987 was expected to number 1,080—almost exactly on the 1,075 target given Peter H. Richardson, '48, director of admissions, by the Academic Council last spring.

By best estimate, there will be 250 women, down from 270 in the Class of 1986 last year.

Minorities will be about the same as last year. More were admitted than for the Class of 1987 than ever before, but it's "very difficult" to convince them to attend M.I.T., Julia C. McLellan, senior associate director of admissions, told John J. Ying, '84, of *The Tech*. "The number doesn't make us happy," she said—"we wanted more."

Just over 90 new transfer students were expected, according to Brenda L. Hambleton, '79, assistant to the director of admissions.

Where will all these people live? Ying asked Robert A. Sherwood, associate dean for student affairs. The fraternities' target is 365 pledges from the Class of 1987, leaving just over 700 freshmen to be accommodated in the dormitory system. In addition, Sherwood said, some 1,900 underclassmen were expected back in the dormitories this fall, and 75 transfer and readmitted students—a total of just over 2,700. Since normal capacity is 2,635, *The Tech* was quick to headline that perhaps 100 freshmen will end up in "crowded" rooms—doubles turned into triples or singles into doubles—at the start of the term.

Eight Writers Tackling Study as Bush Fellows

The first members of the "fourth estate" ever to study in an organized program at M.I.T. arrived this fall, ready to begin work as the first class of Vannevar Bush Fellows. They'll work at the Institute for the 1983-84 academic year, taking classes, attending seminars, and doing special projects with members of the faculty. President Paul E. Gray, '54, calls it "a new partnership between the technical and journalistic communities"; its aim: "continued improvement in public understanding of technology and science and their growing influence on our lives and aspirations."

The eight Bush Fellows for 1983-84:

☐ Paula S. Apsell, senior producer and director at WCVB-TV (Channel 5), Boston.

☐ Karen L. Birchard, science and technology reporter for te Canadian Broadcasting Corp., Toronto.

☐ Diane M. Dumanoski, environmental affairs reporter for the *Boston Globe*.

☐ Catherine Foster, science and energy writer for the Oak Ridger, Oak Ridge, Tenn.

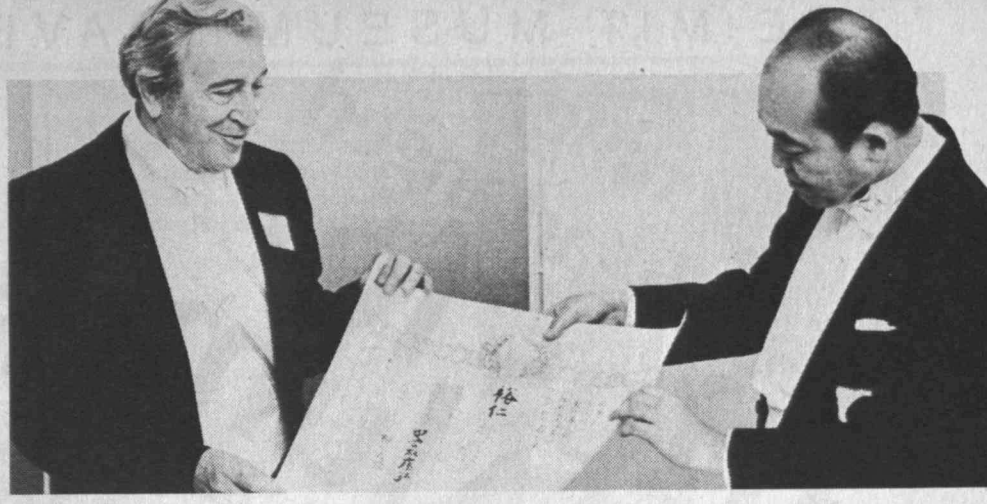
☐ Linda J. Garmon, chemistry editor of *Science News*.

☐ Russ Mitchell, technology reporter for the *Corvallis* (Ore.) *Gazette-Times*.

☐ Mitchel J. Resnick, free-lance technology writer, San Francisco.

☐ Richard C. Saltus, science writer for the *San Francisco Examiner*.

Victor K. McElheny, who came to M.I.T. a year ago from the Banbury Center of Cold Spring Harbor Laboratory, is director of the Bush Fellowship program, and he will be responsible for the year-long seminar conducted for all Bush Fellows by the Program in Science, Technology, and Society.



The highest decoration of the government of Japan—the First Class of the Order of the Sacred Treasure—came to President Emeritus Jerome B. Wiesner (left) last spring. Takeo Iguchi (right), Japanese consul-general in Boston, explained that the award recognized "the extraordinary services you have rendered in promoting science and technology exchanges between Japan and the U.S."—a big step in "enhancing mutual uderstanding and friendship," he said.

Draft Statements Required for Aid

Though he feels the law linking draft registration and federal educational aid is "unfortunte" and "discriminatory," President Paul E. Gray, '54, reluctantly agreed late in July to abide by it. All M.I.T. students must declare that they have registered for the draft or ineligible for it if they want to receive federal loans and grants for the 1983-84 academic year.

Included requirements are Guaranteed Student Loans, Parent Loans for Undergraduate Students, National Direct Student Loans, Pell Grants, Supplementary Educational Opportunity Grants, and College Work-Study Funds. M.I.T. students typically receive over $2 million in grants and $12 million in loans under these federal programs.

"It makes no sense to me to couple educational opportunities with beliefs about the military draft and to apply that connection only to those students who happen to be needy males in a particular age bracket," President Gray said. But he agreed that M.I.T. will comply with the law of the land—the result of a Supreme Court decision supporting a law approved by Congress more than a year ago.

"M.I.T. certainly does not and will not encourage students to disobey the draft registration law," President Gray said. "But we are deeply concerned that the federal government has involved us in its enforcement."

(The other side of that coin was advocated by the Department of Justice before the Supreme Court: without the link between student aid and draft registration, said Justice, the "U.S. will be deprived of a valuable tool to encourage maximum compliance," with the draft-registration law.)

It was a long, hot summer for the Student Financial Aid Office, which has already notified many students of their financial aid plans before the Supreme Court's decision. Each plan was to submit to M.I.T. their signed statements regarding draft eligibility and registration.

Energy Refunds

Surprise! Instead of bills in those envelopes, dormitory residents found checks from M.I.T.'s housing and food services this spring. Small, to be sure, but even $16 was a pleasant surprise.

The money was a fuel cost adjustment, explained George E. Hartwell, associate director of dining housing and food services. The cost of heat and light

Continued on page A18

THE MIT MUSEUM TRAVEL PROGRAM

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WINTERTHUR & WASHINGTON
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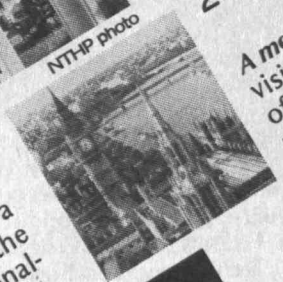

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- look behind-the-scenes at the restoration of air and space craft at the Smithsonian's Garber Restoration Facility
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- greet local alumni at private reception, Woodrow Wilson House, on Embassy Row
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NASA photo

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Classes

Brought together at the Technology Day luncheon in June are the two oldest class representatives, from 1908, Harold S. Osborn (left) and Franklin T. Towle (right). *(Photo: Scott Globus, '84)*

14 70th Reunion

Harry M. Keating writes that he and his wife, Margaret, are still living in Lee, Mass., in the home they built in 1926, soon after he joined the Smith Paper Co. as production manager. He resigned as technical director 25 years later, and, except for trips to Canada and Taiwan as an advisor, has remained in Lee. Harry's letter continues, "As one hobby I started a small business of manufacturing hand-weaving looms. My father in Maine was a ship-joiner, and from him I learned and loved woodworking, building a few boats myself. For 15 years I built up quite a little business, making over 500 looms and shipping all over the country and even to England. I like to brag that I shipped two to Spain, but it was to two brothers named 'Spain' in Kansas City. The looms business got to be too much for me at 87 so I sold it and went back to my old hobby of making inlay pictures from exotic veneers of all colors and grains from all over the world. The Italians call it intarsia, an old art. I have made over 100 of these intricate pictures of attractive scenes we have photographed in our numerous trips across the U.S. and into Canada. Photography developed into a hobby too, from our yen to find the beauty of 14 of our parks from Acadia to Zion."

Fred D. Mendenhall writes that after serving in combat in the U.S. Army in France in World War I and again in World War II, on airport construction in Florida, and surviving several crises, he retired in 1952 and has since lived in Tampa. Fred adds, "My health is reasonably good and my wife is in an excellent nursing home. However, I am 'keeping the home fires burning' alone. My daughter lives in Bradenton. Now, a few months ago I broke the sound barrier of the age 92 plateau and somehow or other I find that I have to slow down. Nevertheless, I hope to remain extant on this planet until NASA puts a man on Mars and we find out what kind of politics and environmental problems they have up there."

My letter of late June to **George B. Zimmele** was kindly answered by his son-in-law, Don J. McGillivray, whose mother married George in October 1978. George unfortunately became totally blind about four months later. After he received his master's degree from the Institute, George worked in a number of places in the eastern U.S. He lived in an historic house in Belleville, Ontario, until his recent marriage when he bought a smaller and quieter home in Belleville. He has adapted remarkably well to his blindness, listens to baseball broadcasts on radio, goes with his wife about twice a month to social events at the local blind peoples club, and attends all of the family gatherings, particularly dinners. He also enjoys Chinese food at a good local restaurant and a drink before dinner on weekends. George and his wife spent some time in Florida last October and hope to go again this year. Although he has not entirely regained his strength after a bout of flu last January and was 93 in September of this year, he is comfortable, well taken care of, and enjoys life. His present address is 21 Southwood Crescent, Belleville, Ontario K8N 1X4, Canada.

A July letter from a grandson of **Constance Fuller Howes** tells of her death in 1973. . . . My June letter to **Walter H. Monahan** was returned marked "addressee deceased." I am seeking information for later notes about these two classmates.—**Charles H. Chatfield**, Secretary, 177 Steele Rd., West Hartford, CT 06119

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Isn't is wonderful that occasionally something new and exciting turns up in our lives? **George Easter** had a 90th birthday party on June 27, and his neighbor, Rita Witek, really gave him a celebration to always remember. She had a buffet dinner for his whole family, who came from Florida, Massina, New York, Cape Cod, and Illinois, as well as many friends and neighbors and ME. I had never been to a '15er's birthday party, and never to a 90th. Everyone had a wonderful time. George wrote since the big occasion announcing that he has fully recovered from the big time but is lonesome with the family all having gone home. He and his neighbor, Rita, were planning to fly to Mexico City in mid August for a week and later drive to his cottage in the Adirondacks for a week over Labor Day.

Ken Boynton recently came through with a note advising he cannot find time to move into smaller quarters as did Ruth **Loring Hall**. Now being past 90, he is spending much of his time trying to keep our country from "going down the drain with liberals." Being a working conservative, it seems to him that everyone and his brother has the idea of starting another fund-needing project. Arthritis is a problem for him in writing or typing, but his classmates and I enjoy hearing from our **Ken Boynton**, as well as from all you '15ers. So here is my punch line: "Come on fellas, keep up the good work and send me a note."

Evers Burtner drove from Kingston, N.H. to the June 1983 Technology Day Luncheon. He also called attention to the excellent tribute to the late very talented William A. Baker, '34, at the Hart Museum and to a fine display of plans, engines, and photographs from Nathanael G. Herreshoff's '70, work shown in the Margaret H. Compton Gallery. When Evers saw **John Homan** in February, John looked very well and was planning his annual trip to southern England. From the Institute, I have a clipping stating that Evers, a true expert on schooners and the famous International Fishermen's Cup Races, spoke on "Recollections of Essex 1908 to 1912, and the International Fishermen's Cup Races of 1922." And from the *Gloucester Daily Times*: "Burtner, while majoring in naval architecture and marine engineering (at M.I.T.), made several trips to Essex and its then thriving shipyards. While working on his thesis, he made a trip on the tug *Sadie Rose* while it was towing the three-masted schooner *Adams*.

"After graduating from M.I.T., Burtner taught in the Department of Marine Engineering and Ship Design and was the curator of the Hart Nautical Museum until 1963. In 1917 he was the only civilian to take part in dive tests of the L-7, the first submarine built at Portsmouth Naval Shipyard. From 1916 to 1968 he was the official measurer for the Boston, Corinthian, and Eastern yacht clubs of Marblehead. In 1922, Burtner was the official measurer for the controversial International Fishermen's Club Challenge between the schooner *Bluenose* of Halifax and *Henry Ford* of Gloucester, and he recalls that that race proved to be his roughest time in 50 years of yacht measuring."

George Easter

Bernard Landers, well known for his charitable and philanthropic work in Jewish circles and organizations, and a great '15er, passed away. He was born in Russia, attended English High School and graduated from M.I.T. with a bachelor's degree in chemistry. He became associated with Phillips Brothers Chemicals Co. in New York, where he became a vice-president, and retired in 1975. He and his wife, Fanny, who died in 1974, had donated the Fanny and Bernard Landers Chemical Lab at Beth Israel Hospital, and he funded the air conditioning of the main dining room at the Hebrew Rehabilitation Center. A great loss to the Class Supreme but we will always have memories of Bernard.

Nelson Stone, of Barnstable, Mass., has also passed on. The last time I visited Cape Cod I had a nice visit with Nelson and his wife. . . . **John Wostrel** died in March. He was a retired senior vocational supervisor for the Massachusetts Department of Education. John retired at the age of 70 and wrote many McGraw-Hill Co. textbooks on radio, television, industrial electricity, and refrigeration. He also had been dean of the U.S. Diesel Engineering School in Brighton. Our sympathy goes to his widow Ivy, daughter Joanne, son Herbert, and four grandchildren. Hope you are getting ready for Thanksgiving and a wonderful fall season.—**Joyce E. Brado**, Class Agent, 491 Davison Rd., Apt. 9, Lockport, NY 14094

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There are not many letters coming in, but we appreciate what we're getting. Keep them coming. In the meantime, we hope you're all well.

Dina Coleman writes, "I have just returned from a Rhine River cruise. We went first to Luxembourg via Icelandair, then on to Luxembourg. From there we went by bus, courtesy Icelandair, to Dusseldorf where we boarded the *Helvetia*. About midway of the cruise there was an explosion and fire in the engine room and everyone had to get off the boat at Mannheim. We went by bus to Basle, by train to

Geneva, and to Paris on the new GVT train at more than 100 miles per hour. We spent four days in Paris and then home to Concord. I have gained back four of the pounds that I lost while in the hospital in March. On August 19 the family is giving me a 90th birthday dinner. Mrs. Fiske is coming down from Boston and George Kittredge, '17, is coming over from Laguna Beach, Calif. They have been close family friends over the years. So it should be a grand party. The Lexington Philharmonic finished the year with a $40,000 surplus, something unheard of before, so everyone is happy. Still eating, drinking, and sleeping—in moderation."

Responding to our June luncheon cancellation, **Henry Shepard** writes, "You were wise. It will be more difficult as time goes on. Thank you for your efforts to keep '16 members together."—**Bob O'Brien**, Acting Secretary, H.E. Fletcher Co., Groton Rd., West Chelmsford, MA 01863

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John Holton writes that he and Sally are "most happy" at Foulkeways, their retirement community in Gwynedd, Pa., north of Philadelphia, where they are well cared for and well fed. He says, "We do want to return to Skaneateles this summer and enjoy a couple of weeks at our old cottage on the lake."

Howard L. Melvin died in Santa Rosa, Calif., on February 3, 1983. For more than 40 years he was associated with Ebasco Services, Inc. of New York City as a planner and consultant of power systems. . . . **Stanley M. Lane** died on May 28, 1983. He was retired president of Lane Brothers Shoe Co. of Boston. From 1957 until 1967 he has served as president of the New England Baptist Hospital and had continued as an honorary chairman of the board of trustees. He was also active in many other civic and charitable organizations. As one of the most regular attendants at 1917 class reunions, he will certainly be missed. He has very likely set a class record by leaving 12 grandchildren and 21 great-grandchildren.—**Walter J. Beadle**, Secretary, Kendal At Longwood, Box 217, Kennett Square, PA

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Our 65th Reunion, which included members of earlier classes, was a most happy three-day program. The following '18ers were there: Rhoda and **Charlie Tavener**, Winifred and **Sumner Wiley**, Dolly and **Eli Berman**, Eunice and **Theodore Braaten**, Gladys and **Leonard Levine**, Selma and **Max Seltzer**, Patricia Murray and **John Kiley**, Elizabeth Howe, Hazel Fletcher, Olive Roberts and Elinor Kilduff. In addition, fellow alumni Fred Vogel and grandson Eric Adolphson, Pearl Wechsler, Pat Erb, Marvin Pickett, Maurine and Allen Brewer, and Maurice Root added to the joyous fellowship of this get together.

Despite the fact that many of us had never met before, this group became most congenial almost immediately after our Thursday registration. All our events were enthusiastically enjoyed. I call this reunion the best yet, the only regret being that so many were physically unable to be with us or have gone to their great reward.

Maurice Root, '14, who came from Rockland, Maine, despite his inability to see and hear well, writes, "Thank you for enticing me to come to the reunion. With so much pleasure, all my pains were wiped out. The student assistants were wonderful help, and I was overjoyed that the coeds are beautifully feminine, not obstreperous feminists.—**Max Seltzer**, Secretary, 143 Beacon St., Brookline, MA 02146; **Leonard I. Levine**, Assistant Secretary, 519 Washington St., Brookline, MA 02146

19 65th Reunion

Classmates planning to attend our 65th Reunion were listed in the August/September issue of the *Review*. I now add **George R. Bond, Jr.** Your reunion committee is busy with plans and arrangements in preparation for a mailing with particulars to the class.

You will be interested in a few comments from those who responded but cannot attend. **Robert Insley** has vision problems but says, "Interested in news, many thanks.". . . **Jacob J. Bolotin**, "Health does not allow it, but best wishes to all my classmates." . . . **D. Arthur Lundquist**, "Not able now, and surely will not be able in 1984." . . . **Milton A. Loucks** was unable to write but sends greetings to his classmates. . . . Professor **Wayland S. Bailey** writes, "Retired, busy—chairman, blding. and grounds for local church. Both Jessie and I are slowing up a bit, but keeping fairly active." . . . **Robert S. MacMullin**, "Sorry, blindness makes it impractical." . . . **Harold M. Putnam** is in a rest home and unable to attend.

Edward C. Anderson writes, "Sorry, health problems, age approaching 90 years." . . . **Alan G. Richards** writes, "Regret I cannot attend, regards to you and others of '19." . . . **John S. Carter** responds, "Ill health prevents me from attending." . . . **Joakim Lehmkuhl** is under nursing care at home. . . . **Abraham J. Williams** writes from Honduras, "I am sorry that my bad health does not permit me to travel. Hope you will have a pleasant reunion." We will miss these classmates, that is those of us who are fortunate enough to attend, and I am sure all those who cannot do so will not be forgotten.

A note from **Besse Fichter** advises, "Retired from all activity as I am housebound and confined to a wheelchair."

These notes in the absence of other news deal mostly with a big event in our class, the 65th Reunion. Written in early July I hope that when you read them you will have had a lovely summer.—**W. O. Langille**, Secretary, Box 144, Gladstone, NJ 07934

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A welcome letter from **Karl Bean** of 55 Early Redberry Lane, Yarmouthport, Mass., says that he and his wife are living happily on the Cape and that he is still going strong. He says, "Give my best to all the boys that you come in contact with from time to time." Karl wrote me about the death of **Al Wason** who lived in Barnstable, Mass.

In previous notes I mentioned the gathering of old timers at Endicott House and, later, the Technology Day assembly in Cambridge. I regret that I was unable to be present on these occasions. I believe the only representative of the class at Endicott House was **Harry Kahn** and his wife, Hannah. At the Tech Day luncheon were Pat and **Buzz Burroughs**, Kay and **Frank Maconi**, **Elbridge Wason** and his daughter, **Al Burke** and **Phil Wait**. If I've left anybody out please let me know so I can apologize.

Word has just reached us of the death of our perennial class president, **Norris G. Abbott** of 1180 Narragansett Blvd., Edgewood, R.I. on July 17. Norrie had been looking forward to the 65th reunion of the class. He leaves his wife, Betty, who was kind enough to assure us that his illness was not prolonged and that he suffered no pain. A more complete obituary will appear in next month's *Review*. A great loss to us all.

Joshua Muss of 4-16 Fourth St., Fair Lawn, N.J. died on the same day as **Al Wason**, April 17. A note from his son, Milton, '53, says, "He was a loyal supporter of M.I.T. and talked of the school and its many attributes since I was a child." We shall miss this popular and well known classmate.—**Harold Bugbee**, 21 Everell Rd., Winchester, MA 01890

21

It's a beautiful sunny morning "On Golden Pond"—otherwise known as Squam Lake, N.H. Betty and I are here for five weeks and your secretary is enjoying a lazy life with a certain amount of easy hiking, canoeing, and swimming.

I am indebted to **Bob Miller** for a report on Technology Day this year. Written from South Chatham on Cape Cod he says that the class was represented by Maxine and **Cac Clarke**, **Don Morse**, **Frank Whelan**, **Helen St. Laurent**, **Whitney Wetherell**, Helen, and himself. This was the largest representation the class has had in several years. "All reported certain health problems but in stable condition," said Bob. The Millers were planning to leave Cape Cod a few days later and take a swing through Massachusetts over to Syracuse and then south to Williamsport, Pa. before returning to their home in Maryland.

In a phone call to **Irving Jakobson** late in May I learned that he and Ruth had taken a guided tour in Texas in March. Among the places visited was a big ranch containing lots of wild animals—zebras, giraffes, etc. Jake said that they were both well.

Betty and I attended her 60th Reunion at Simmons College the first week in June. We had a grand time, with exceptionally fine meals, reminiscing, and good fellowship. Simmons evening at the Pops was fun. A number of times I ran into **Mark Hamburger** who was attending another class reunion with his wife. Mark and his wife seemed to be in fine shape.

A letter from **George Schnitzler** late in June told of his being in and out of hospitals this past year for an abdominal condition. He said he now feels much better but "getting into the mid-eighties is no fun and I guess most of our class of 1921 is in the same boat." Too true! George asked for Bob Miller's address because at our 60th Reunion banquet they promised to exchange pictures they had taken. George had slides taken at a number of our reunions including the Cuba reunion in 1958.

There are five deaths to report this month:—**Frederick J. Grant** of Ojai, Calif. on September 28, 1982; **Clayton C. Westland** of Scarsdale, N.Y. during 1982; Captain **William J. Malone** of Largo, Fla. on March 14, 1983; **Donald H. Hatheway** of Geneseo, N.Y. on April 11, 1983; and Professor **Lee J. Purnell** of Washington, D.C. on April 28, 1983.

Grant earned an A.B. in chemistry at Yale in 1917. He was a captain in the Air Force in World War I. During his career he was president of Gladding, McBean, and Co. in Los Angeles, chairman of the board of Hayward Scientific Glass Co. in Whittier, Calif., and finally worked for Grant-Jacoby Co. (sales) in Los Angeles. . . . Westland worked in various positions for McCall Corp. in New York City, attaining the rank of vice president and director. . . . Captain Malone was a retired navy captain who spent most of his career at the old Bureau of Construction and Repair. During World War II he supervised the design and construction of several Essex class aircraft carriers. . . . Hatheway retired in 1963 as head of the Protection Division, Boston Edison Co. . . . Professor Purnell had a distinguished career in teaching at several colleges and universities and was director of education for the old Civilian Conservation Corps in San Francisco. He retired as professor of electrical engineering at Howard University. The sympathy of the class is extended to the families of these classmates.—**Sumner Hayward**, Secretary, 224 Richards Rd., Ridgewood, NJ 07450; **Josiah D. Crosby**, Assistant Secretary, 3310 Sheffield Cir., Sarasota, FL 33579; **Samuel E. Lunden**, Assistant Secretary, 1149 S. Broadway, Suite B-800, Los Angeles, CA 90015

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Luncheon in the Athletic Center on Technology Day was attended by **George Dandrow**, **Ted Miller**, **Hall Baker**, **Walt Saunders**, **Buck Eacker**, **Marjorie Pierce**, **Randy Myer**, **Oscar Horovitz**, **Win Potter**, and your secretary. At the presentations following lunch, **George Dandrow** was awarded the Bronze Beaver, a long delayed tribute to his continuous service to the Institute and our class.

The class will be glad to learn that **Arthur Mattuck**, our Class of 1922 professor, has been proposed for another five-year term. A letter from Provost Francis E. Low to **Parke Appel** described some

of Professor Mattuck's activities as follows: "He is currently giving large lecture classes in calculus to over 400 freshmen, and in modern algebra to most of the electrical engineering students (over 200), as well as doing research and supervising the undergraduate mathematics program. He is an active participant in studies of ways of improving the teaching of TAs throughout the Institute, and of utilizing the IBM personal computers M.I.T. will be receiving to good educational advantage in the elementary mathematics courses. He has designated the money accompanying the chair as the Class of 1922 Fund for the Advancement of Teaching."

Quoting from a recent note from **Walt Saunders** and with permission from the victim in a "Man Bites Dog" event: "A short time after returning from Technology Day, **Hall (Baker)** was knocked down on the sidewalk in front of his office by a boy on a bicycle (We do have a few sidewalks in Cape Elizabeth). Fortunately, in spite of being flattened, no serious damage resulted except a lacerated chin which necessitated a "Talbot beard."

A letter from **Frank Kurtz** enclosed a page from the current **American Contract Bridge League** magazine announcing the New England Frank Westcott Fall Regional Bridge Tournament. Many of us will remember **Frank Westcott** who prior to his death some years ago was president of a successful construction company in North Attleboro, Mass. As **Frank Kurtz** says, "He was without doubt the top bridge player of the Class of 1922. I guess he was also the top player of Providence. Quite an honor (among bridge players) to have a tournament in your name.'

Ab Johnson spent the summer at his hideaway at Crystal Downs near Frankfort, Mich. Your secretary went to his 65th reunion at Andover last June. Of the three of the class of 1918 who showed up, two were M.I.T. 1922, **Bill Gray** and myself. The old folks seem to be losing interest.

Bill Elmer is making progress in urging the adoption of the 40-inch meter. He is quoted extensively in the *Australian Metric Record*, a publication devoted to telling "the truth about metrication in Australia." If anyone is interested in learning more on this subject, write to Bill at 2 Chestnut St., Andover, MA 01810 and to the publisher of the AMR, the Modular Conversion Bureau, Box 61, Post Office, Clarence Gardens, 5039, South Australia. Bill wants the 1975 (U.S.A.) Metric Conversion Act repealed and also wants the 1866 law that makes the metric system legal in the U.S. repealed or changed so that a 40-inch meter "is legalized in place of the 39.37" monstrosity that is part of the SI system."

Martha Eiseman Munzer is at it again. The *Hartford* (Conn.) *Courant*'s magazine section of the July 10, 1983 issue has a three-page article by Martha entitled, "The Blessing of Growing Old." In this article is the interesting disclosure that Martha is married again to "a new and remarkable husband (Corky, age 86) my long lost lieutenant of World War I." Our congratulations, Martha, on your ability to continue such an active life.

C. Herbert Taylor died in Cumberland, R.I. April 7, 1983. After M.I.T. he received a master's degree in education from Bates College. In 1935 he became principal of Cranston East High School in Rhode Island and later superintendent of the Cranston schools from 1956 until retirement in 1966. He is survived by a daughter, two sons and eight grandchildren. . . . **Lloyd Harrison**, age 84, died May 5, 1983 in Washington, D.C. He was a graduate of Annapolis in 1919 and had a master's degree in naval architecture from M.I.T. He had an extensive career in the Navy, retiring in 1955 as rear admiral. Thereafter he was vice-president of McDonnell Aircraft in charge of procurement. After a second retirement, he became receiver of the Howard Foundry in Evanston, Ill. He is survived by his wife, two sons, a daughter and eleven grandchildren. . . . **Carl W. Shattuck** died August 17, 1981. He had been president of McKierman-Terry Co. in Dover, N.J. I have no knowledge of his surviving family. . . . **Thomas S. Shepherd** died June 6, 1983 in St. Petersburg, Fla. He was a member of Delta Upsilon. I believe he had been, before retiring, regional manager in Maine for Cities Service Oil Co. He is survived by his wife, two sons, a daughter and eight grandchildren. One of his sons, Thomas E. Jr. is M.I.T. '50. Our regrets on the loss of these classmates are extended to their families.—**Yardley Chittick**, Secretary, Box 390, Ossipee, NH 03864

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Including class members, wives, widows, and guests, 60 of us attended various parts of our 60th Reunion, June 8-10 in Cambridge and June 10-12 in West Dennis at the Lighthouse Inn. In Cambridge were **Alan Allen**, **Bill Allis** and guest, **Fred Almquist**, Mary and **John Berretta**, **Louise Clapp**, **Phyllis Davenport**, Peggy and **Louis Domingues** and their granddaughter, Alice and **Tom Drew**, Jean and **Jerry Fitzgerald**, **Bernard Flynn**, **John Frank**, Elizabeth and **Dick Frazier**, Ida and **Cecil Green**, Ella and **Harry Green**, Esther and **Earl Griswold**, Grace and **Ray Holden** and their daughter, **Dave Joy**, Elizabeth and **Howard Lockhart**, **Bill Lowry**, **Pete Pennypacker**, **Pat Proctor**, **Al Pyle**, **Conchita Pearson**, Marge and **Tom Rounds**, Mary and **George Rowan**, **Isabelle Skinner**, Mary and **Royal Sterling**, Kay and **Julius Stratton**, Helen and **Lem Tremaine** and their son and daughter-in-law, and Florence and **Walter Webster**—a total of 51 persons. On Wednesday evening, June 8, we had our class dinner (preceded by a cocktail hour) at the Museum and Historical Collections. Paul and Priscilla Gray were our guests; Paul spoke briefly about the state of the Institute. Howard Johnson came for the cocktail hour. Dottie Adler and Janet Lambert represented the Alumni Association. Royal Sterling read a number of brief letters from classmates. At our class meeting on Thursday, the slate of officers proposed by the nominating committee was unanimously elected, the reports of the secretary-treasurer were presented and accepted, and the McKittrick bell was voted into the custody of the Museum and Historical Collections. A Happy Hour followed the meeting, then the Pre-Pops Buffet, and then Tech Night at the Pops. On Friday morning of Technology Day was a symposium on artificial intelligence, followed by a memorial service at the Chapel, a sherry party for class secretaries and guests, the Alumni Luncheon, and the dedication of Ida Flansburgh Green Hall. Among the announcements made at the Luncheon was the sum of $7.2 million in gifts from our class to the Institute during the past five years. Just prior to the Luncheon a re-enactment of the Harvard-Yale game balloon prank was staged.

To avoid the worst of Friday afternoon traffic to the Cape, 33 of us who went to West Dennis had to leave prior to the dedication of Green Hall. At West Dennis, we were met by Katie and **Herb Hayden**, Marion and **Bill LaLonde**, Audrey and **Paul Moore**, and Mary Margaret and **Leander Poor**. **Horatio Bond** dropped by for a few hours on Saturday, making a total of 42 of us at the Inn. That day we had orgies of clams and oysters, a lobster dinner, kite flying, poetry by Pete Pennypacker and singing led by him, prizes, and gifts for the ladies. That night we viewed the class film, edited into one reel at the Museum, from graduation through the 50th Reunion. The R.O.T.C. pictures, mentioned previously a few times in the Notes, were on exhibit in hope of obtaining additional identifications beyond those made by Fitzgerald, Holden, and Joy, but without success. They and the class film now are on deposit at the Museum. An engraved plaque was awarded to **Rod Goetchius** (who could not be present), an M.I.T. chair to Royal Sterling, and an honorarium to Dick Frazier for services to the class. Fine weather held throughout the reunion. Copies of the reports of the Secretary-Treasurer will be mailed to classmates who request them. Copies of the *Great History* will be sent, one each, in order requested, to widows who have none, upon request to the Secretary-Treasurer, as long as the supply of about three dozen lasts. We thank all who contributed prizes and gifts.

A lengthy letter from **Howard Russell** brought greetings to the class from Sun City, Ariz. Howard has suffered considerable loss of sight and hearing, but has good general health and does very well with the assistance of friends and organizations to which he belongs. He is interested in military history, especially involving aviation (due to his World War pilot days), and in genealogy, having traced his ancestry back through the Battle of the Bridge at Concord in April 1775, to 1611. Xerox copies of his letter were distributed at the class meeting. . . . **Tom Powers** reports that he had a heart attack in 1976 which has somewhat limited his activity, and he and his wife Margaret will celebrate their 50th wedding anniversary August 26, and that he is retired from the hotel business, having sold the last one, the Powers Hotel, nearly a year ago. . . . **Al Pyle** has had a trip to Galapagos Islands with some good snorkeling. . . . **Bill Upham** reports that he has been on the Board of Trustees of Eckerd College, formerly Florida Presbyterian College, since it started 22 years ago; he gave it the Upham Administration Building. . . . **Tom Drew** has been elected to membership in the National Academy of Engineering on account of his "pioneering contributions to heat/mass transfer and nuclear engineering technology, educational leadership, and outstanding service to government and his profession."

Elliott Adams died on December 18, 1981. He graduated with our class in Engineering Administration. Thereafter, he spent three years at Vaughan Knitting Co. in Pottstown, Pa. and became finishing mill superintendent. In 1926 he joined the Massey Harris Co., Ltd., of Toronto, Canada, and Racine, Wisc., a world-wide farm machinery manufacturer. In 1948, he was made vice president of engineering at Racine. In 1957, he moved to the J.I. Cass Co., where he was engaged in central engineering and product planning. He retired in 1969. During 46 years of association with farming, he travelled to many farming areas of the world. His hobbies were history, photography, and farm machinery. . . . **Oscar Perkins** died on April 8, 1983. He graduated with our class in Electrochemical Engineering. In 1948, he was a Major, A.U.S., O.R.C. instructor in Hartford. We have no further information about his professional career. . . . **Alfred Pearlman** died on April 30, 1983. He graduated with our class in Civil Engineering, then studied at Harvard School of Business Administration, then at Clarkson Institute of Technology, where he received his D.Sc. degree. He was awarded an honorary L.L.B. degree by DePauw University. After graduation from the Institute he entered the employ of the Northern Pacific Railway as track laborer and construction draftsman, and successively became system inspector of icing facilities, assistant supervisor of bridges and buildings, road master, and assistant to the vice president. He then moved to the Chicago, Burlington, and Quincy Railroad, and then to the Denver and Rio Grande Western Railroad. In 1954, he became president and director of the New York Central System; in 1968, upon the merger with the Pennsylvania Railroad to become the Penn Central, he became director and chief administrative officer and vice chairman of the board. Two years later he became president of the Western Pacific Railroad Co., which involved him in official capacities with other associated railroads and businesses. After retirement from Western Pacific he served as a director of the Commercial Metals Corp. in Dallas. He served the U.S. government as consultant to the Railway Division, Reconstruction Finance Corp., consultant to the Department of State on Korean Railroads, and consultant to the government of Israel on the country's railroads. During World War II he served as engineering consultant to the Defense Plant Corp., and as co-chairman, Military Airlift Committee, U.S. Air Force N.S.T.A. He was a member of numerous professional, honorary, and social organizations, and the recipient of several citations, awards and medals; trustee, American Museum of Immigration, Denver University, and Elmira College; author of numerous articles for professional and trade journals.

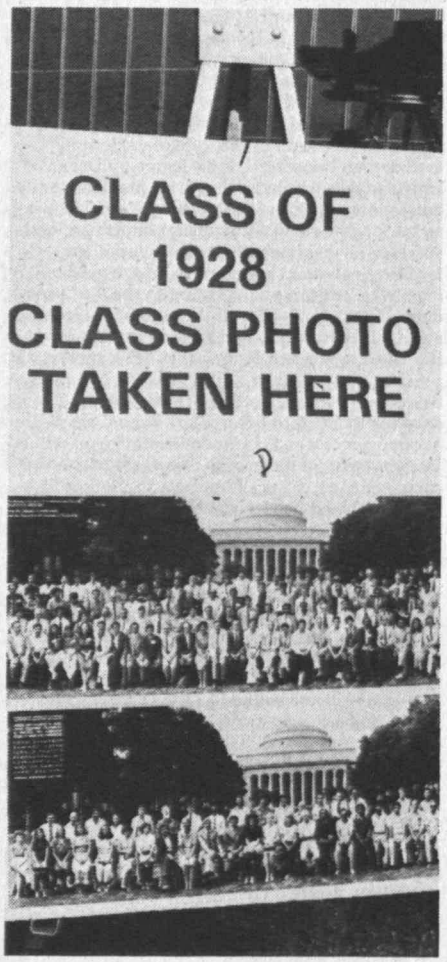
William Wolfe died on May 12, 1983. He graduated with our class in Mining Engineering and Metallurgy and took a J.Dr. degree from New York

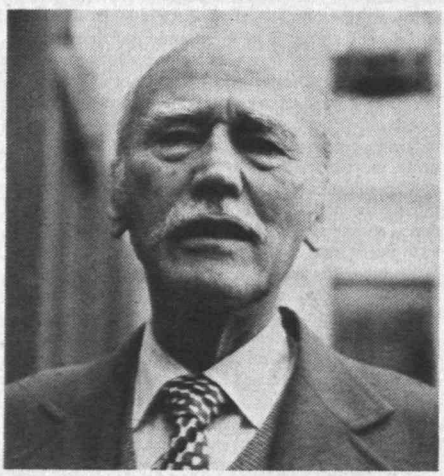
M·I·T
XXVIII
CLASS OF 1928

FIFTY-FIFTH REUNION
JUNE 1983

INSIDE: We Express Our
"THOUGHTS and SENTIMENTS"

Looking Backward Into the Future





"Every age has been shaped by its history, and future ages will be shaped, in part, by what we have accomplished in our days," writes Robert Hennes in the Class of 1928 55th Reunion book, *Thoughts and Sentiments*. When Walter Smith, class secretary, asked classmates to share their life philosophies, predictions for the future, and words of wisdom from their own unique vantage points, 113 responded.

Replies were diverse, as are the backgrounds of these '28ers who have lived through most of an "extraordinary and amazing century." "Please don't give in to the notion that you have nothing to offer," Smith encouraged. "You are among the few people who can still remember what it was like to live in a horse-drawn world without radio, TV, plastics, refrigerators, computers, or air travel."

From one-room schoolhouses to M.I.T., from slide rules to computers, from horses to the first man in space—one common bond among these graduates is the experience of tremendous change. "One of the most pervasive factors in life is change," says Charles Carter. "We may abet it or accept it, discourage it or reject it—eliminate it we cannot." Specialization now allows us to accomplish many things more quickly and with less effort, but whether these changes contribute to increased happi-

"To mature is to create oneself endlessly."

"Nothing is as bad as it seems at the time."

"Be trusting, but not naive."

"Do not over-consume."

"Be careful what you want–you'll get it!"

"For age is opportunity, no less than youth itself, though in another dress."

"We should not abandon our optimism."

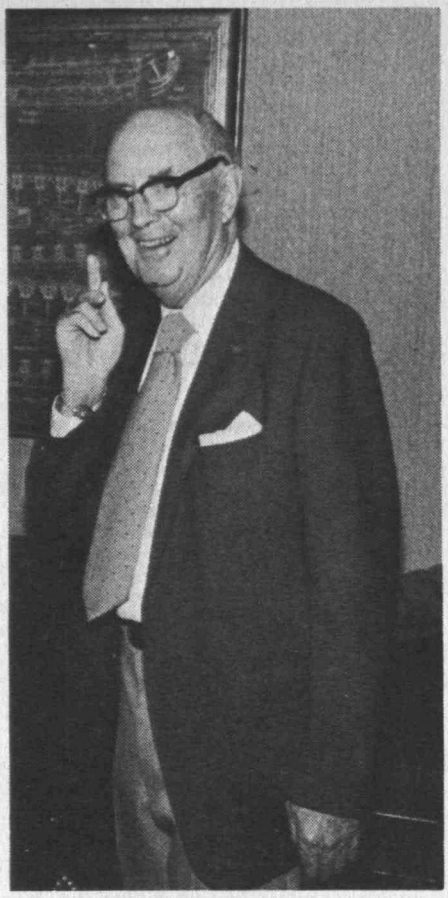
"Don't be guilty of not trying."

"Work for a noble cause."

"Go the second mile."

"Make your pyramids on bases stand."

"Keep an open mind."



ness isn't easily evaluated, he adds.

Martin Brillhart sees the computer as the crowning achievement of the century. Because it deals with a "non-material" entity-memory, he says, "we have fabricated an element in the thought process."

While many respondents note great technical achievements of the age, they also stress that our social abilities must keep pace. "Unfortunately we have not had the capacity to understand other people's cultures, beliefs, and ambitions, or at least help organize a world free from fears of wars, famines, and cruelties."

Advice to Present-Day Graduates

Get the finest education possible, and then choose a career which will involve your enthusiasm. Work for a noble cause . . . with devotion. Have the restriction of discipline—a giant part of wisdom.

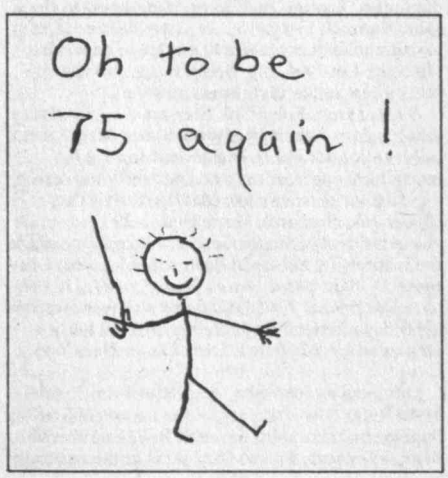
One strongly expressed common theme is the importance of tolerance and open-mindedness. Study not only math and engineering, says Frederick Lewis, but also humanities and social sciences. Get to know people in other countries, their cultures, their languages.

It is an expansive philosophy. "Take on other activities in new and strange ways of living, seeing new places and meeting new people," writes Stewart Newland. Such an outlook takes one far beyond self. "To make one's life really complete, it is vital to participate in charitable and civic enterprises," says Lawrence Glassman.

The Future?

Many '28ers express an indomitable curiosity about life, the challenges of today, and the future. Some are concerned over the global outlook. "Hopefully, our descendents can cope with the legacy we have left them," sayd Henry Buntschuh. "The world is doubtless going to hell in a hack and has been since the dawn of the history. That it never reaches that destination is possibly because the road is knee-deep in good intentions," says Charles Worthen. He adds, "It is now time for us to relax, like Candide, and cultivate our gardens."

One final comment by Martin Brillhart: "The creator seems to think one century is about all we humans can stand. Personally, I would like to be around to see how it all comes out."—*Sandra Knight*



University in 1929. He worked as a topographical engineer for the Boroughs of Queens and the Bronx, and then became an attorney in the Law Department of the City of New York and a member of its Condemnation Division. Fifteen years later he moved to the Contract Division and later took over all patent litigation for the City. He retired in 1964, but became briefly involved in private patent law practice, and then took a second retirement in 1965 and moved to Florida. He and his wife joined the Wally Byam Caravan annually, travelling through northwestern Canada with their trailer.—**Richard H. Frazier**, Secretary-Treasurer, 7 Summit Ave., Winchester, MA 01890

24 60th Reunion

One of the disconcerting happenings to report is the resignation of our class president, **Phil Blanchard**. He writes that because of the poor health of his wife, Besse, he finds it impossible to take the time away from home to carry out his responsibilities. He has asked **Don Moore**, executive vice-president, to assume his duties. This somewhat overloads Don, as he had previously replaced **Frank Shaw** and **Ed Moll**, co-chairmen of the 60th Reunion.

The Records office sends a notice of the death of **Melvin Wagner** on May 8, 1983 in Bridgeport, Conn. He was awarded an S.B. from Course XV and was credited for originating the pouch within a pouch for food and medical supplies. He was noted as a classical pianist and preparer of gourmet cuisine. . . . **Jacob A. Manian** of Baltimore, Md. passed away on April 10, 1983. He received his S.B. in electrical engineering and a law degree from George Washington Law School. He served as a patent lawyer at the U.S. Patent Office until his retirement. He is one of three brothers who graduated from M.I.T.

An interesting note, newspaper clipping with picture from **Sam Zerkowsky**, Slidell, La., indicates that he will be holding his annual "Sam Zerkowsky Golf Tournament" celebrating his 80th birthday. The paper says, "He does not look anywhere near the age of 80." Golf is his avocation, but his interest is "Tammia Nursery," the largest collection of camellias in the world. He will bring slides to show at our 60th.

A note from **Dick Shea** in South Yarmouth on Cape Cod brings the sad news that his wife, Helen, failed to survive a heart attack in San Diego while they were taking a trip. Dick is an avid golfer but now misses his wife's inquiries on his game. He and Helen were enthusiastic about our approaching 60th. . . . The lawyers representing the executor of the estate of **Robert B. Davidson** advises that he died February 5, 1983. Our records indicate that he was an architect major and affiliated with the Sun Oil Co. in Boothwyn, Pa. . . . **Reginald B. Miner** passed away May 26, 1983 in an Acton, Ma. nursing home. He gained a B.S. from Dartmouth in 1921 and was awarded an S.B. in architectural engineering. He joined Monk and Johnson, architectural engineers, Boston. In 1928 he transferred to the John Hancock Insurance Co., later becoming the assistant manager of the city mortgage department. He retired in 1964 as a vice-president in the company's real estate investment division.

A letter from Robert W. Stewart, Jr., '54 advises that his dad, **Robert W. Stewart**, died May 7, 1983 in New London, N.H. He earned his S.B. in mechanical engineering, and circa 1949 was managing director of the Singer Manufacturing Co., Clydebank, Scotland. He retired in 1964 as senior vice-president of Singer Co. . . . A telephone call to the Institute by his son in Boston, advises that **Laurence D. Bain** passed away June 5, 1983. He prepared at the U.S. Naval Academy and was awarded his S.B. in general engineering. In 1949 he was employed by Western Electric Co. in New York City.

Your scribe received a long letter from **J. Adelberto Roig**, now chairman of the boards of Sterling Sugars, Inc., Franklin, La. and Roig Commercial Bank, Humacao, Puerto Rico. Al is enthusiastically looking forward to our 60th next year, although on June 9 he was hospitalized in New Orleans for surgery on his arthritic left knee, badly injured in soccer at M.I.T. And if his ailing right knee gives out, his ever-increasing family will have to barge him to the States while he enjoys his favorite sport, ocean fishing aboard. Also from Puerto Rico, the good news that the Honorable **Luis A. Ferre** has received the NSPE award, the highest honor bestowed on individuals by the National Society of Professional Engineers. Luis was the former governor (1969-1972) of that commonwealth. He has demonstrated an unusual combination of humanitarian, artistic, and technical capabilities. He has received a total of ten doctorates from institutions such as Harvard Law School and the New England Conservatory of Music.—Co-secretaries: **Russ W. Ambach**, 216 St. Paul St., Brookline, MA 02146; **Herbert R. Stewart**, 8 Pilgrim Rd., Waban, MA 02168

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Your secretary has to report that for the first time in years he had to miss the 1983 Alumni Day activities. **Jim Howard** and **Sam Spiker** write to say they were at the annual luncheon and were joined by **Ed McLaughlin** and **Frank Mulcahy**. My excuse for being absent follows. On the evening of May 25 I became violently ill and by 11:00 p.m. it was clear I belonged in the hospital. The Chatham Fire Department has an excellent emergency medical team. They responded at once and by midnight I was in the emergency room of the Cape Cod Hospital in Hyannis. After many tests it was determined that surgery was necessary and at 5:30 a.m. I was wheeled into the operating room. The problem was a perforated ulcer located in the upper stomach area and near enough to the diaphragm so that matters were complicated because much infectious material had gotten into the chest cavity. This meant antibiotics and for eight days I was in the intensive care unit. But following another five days of regular hospital care, I was discharged to come home for recovery. Evelyn, who calls herself "a rusty old nurse," took over then. I was provided care much better than would be available elsewhere. In addition, she has been gardner, chauffeur, and secretary. I hope by the time you read this that my recovery will be well advanced.

The Stanford University News Service issued a most interesting four-page release on April 28, 1983. The article was entitled, "Computer Pioneer and His Historic Program Still Active at Stanford." The pioneer is **Arthur Samuels** now adjunct professor emeritus in computer sciences at Stanford, and he has been working in computers for years. He first got interested in computers at M.I.T. and in 1923 started working with Vannevar Bush on the differential analyzer. Perhaps some classmates would be interested in this entire article which should be obtainable through Stanford University or perhaps some would rather write to Arthur directly at Computer Science Department, Stanford CA 94305.

A note comes from **Foster York** in Evanston, Ill. Foster lost his wife Ann about nine years ago and in March 1980 was married to Rosemary. He is still active as a partner in his law firm in Chicago.

It is with great sorrow that I have to report the passing of **George L. Washington** on June 4, 1983. He had suffered a heart ailment and died at his home in Washington, D.C. He was a retired director of the College Service Bureau and a former official of Howard and several other universities. George was the son of a Baptist minister, was born in Norfolk, Vir., but as a boy lived in Cambridge, Mass. attended high school there before entering the Institute and obtained both the S.B. and S.M. in mechanical engineering. Following graduation he joined the faculty of North Carolina A&T State University in Greensboro. He later moved to Tuskegee, where he was an assistant to its president, F.D. Patterson, and held various other posts. The College Service Bureau was established in 1969 under the auspices of the United Negro College Fund and the Phelps-Stokes Fund's Cooperative College Development Program. Its purpose was to keep member colleges abreast of federal programs that could assist them. George moved to Washington, D.C. in the late 1950s. Before setting up the bureau, he had been an assistant to the president of Howard University and then its business manager. He also had been a college housing official with the Department of Housing and Urban Development and had worked with the Agency for International Development in Indonesia. During World War II, he played a major role in negotiating the establishment of the Army Air Forces flight training school for black pilots at Tuskegee Institute at Tuskegee, Ala. Graduates of the school formed the famous 99th Fighter Squadron which saw service in Europe during the war. George retired from the College Service Bureau about 1979. He was a Mason, a Baptist, and a member of the Tuskegee Airmen, the Defense Orientation Conference Association, and the board of trustees of the Aerospace Education Foundation. Survivors include a daughter, Yetevia Washington Campbell of Austin, Tex., and two grandchildren. A memorial service was held on July 8, 1983 at Andrew Rankin Memorial Chapel, Howard University, Washington, D.C.

Four classmates have passed on. **Richard L. Gatewood** died on February 14, 1982 at Atlanta, Ga.; **Robert Hodson** died on May 16, 1982 at East Boston, Mass.; **Beverly Hubbard** passed on February 28, 1983 at Princeton, N.J.; and **Edward S. Johnston** died on May 4, 1982 at Mesa, Ariz. No other details are available.—**F. Leroy (Doc) Foster**, Secretary, 434 Old Comers Rd., P.O. Box 331, North Chatham, MA 02650

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Our 57th mini-reunion at Technology Day was attended by 16 of our classmates most of whom were accompanied by their wives. It began with dinner at the M.I.T. Museum, followed by Pops that evening, lunch at the general alumni gathering, and dinner at the Student Center the following day. It gave us all time for a quiet, pleasant exchange of reminiscences and current news of old friends' activities. Good health was reported by practically all attending, no mean achievement considering age levels hovering around 80 years. Some interesting views were expressed through a questionnaire which would be of such general interest that some of the results are noted herewith: Of 16 married there was only one divorced. There were 35 children, 114 grandchildren, and nine great-grandchildren. One-third were still actively working. Annual income was over $20,000 for one-third and over $50,000 for two-thirds. There were 13 Republicans, no Democrats, and 3 "others." Those in favor of continued nuclear power plant construction—unanimous yes. For a nuclear freeze (yes-2, no-13). In favor of U.S. overt involvement in Latin American affairs (yes-10, no-5). A pleasant byproduct of the mini-reunion was a large number of responses to the mail notices from those who were unable to come. We note abbreviated replies from them. **Wallace K. Newcomb** writes, "Have just returned from Florida, and for the next two months will be busy catching up on my skiing with the 70-plus ski club and giving my six year old grandson the benefit of many years of skiing experience." . . . **A. L. Entwistle**: "Would like to be there and congratulate classmates who work so hard to keep '26 alive and kicking. Have many business problems which may keep me here in Kentucky." . . . **Cesar S. Canals**: "Will do my best to be with you all but am kept busy traveling. Best wishes." . . . **Albert Ortenblad**: "From Brazil, too long a trip—gladly transfer to you my quota in the fun." . . . **John B. "Bud" Wilbur**: "Sorry, I wish it were practicable to there. Thanks for mention of 'Sons of M.I.T.' in the class notes." . . . **Charles E. Poore**: "Long distance travel out. Golf once a week. Come by the 'Poore House' sometime when you are in Florida at 500 North Phelps Ave., Winter Park, FL 32789."

Harry F. Howard writes: "Not up to coping with such an active program. Would welcome a visit here from any classmates who may be visiting the Cape at 350 Tonset Rd., Orleans, MA 02653." . . . **Thomas J. Eaton**: "Have recently been confined to the hospital as a result of a compression fracture of the spine." . . . **Martin Fireman**: "Leaving on trip to Alaska on June 11, so we may be busy with preparations." . . . **Martin L. Grossman**: "We have been doing some travelling in the Caribbean area. Still doing some consulting in the power field in Latin America, etc." . . . **G. Malcolm McNeil** in a letter to **Don Cunningham** felt that travel to Boston was a bit too much and in harking back to M.I.T. days recalled playing scrub basketball with a (then) Siamese named Sukhavanija listed in the Class of '27, and wondering what became of him in view of troubles in (now) Thailand.

Crockett Harrison mentioned his attendance with his wife at his 60th from Westminster College which was a little too much for her considering a history of recent heart bypass and valve replacement. Therefore they were in some doubt of their being able to make the 57th. We would have liked to talk to him about his large and close-knit family now including great-grandchildren. . . . **John Longyear** regretted his inability to attend the 57th, hating to miss the opportunity of visiting with his classmates. . . . **Eben Haskell**: "Am recovering from an operation for a partially detached retina which at the present has me grounded making the possibility of attending somewhat doubtful."

We were just notified of the deaths of **Thornton W. Owen** on July 4, 1983 and **David A. Shepard** on July 10, 1983. We have received no further information at this time but will publish details in the next issue.

A delayed notice recently received by the Alumni Association from his widow announces the death in May 1982 of **James B. Powers**. Bruce, as he was known to most of us will be remembered as a four-year member of the wrestling team as well as many other accomplishments. . . . Death of **Leonard Kaplan**, who received his M.A. in naval architecture with our class occurred May 12, 1983. He had graduated from Annapolis in 1922. His career included the supervision of the construction of three carriers and the battleship *North Carolina*. Captain Kaplan continued his career after retirement from the navy as a naval architect in New York until his retirement in 1980. He is survived by his wife, Ethel, one son, and four daughters.—**William Meehan**, Secretary, 191 Dorset Rd., Waban, MA 02168

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Our alumni records show that there are presently 28 widows of classmates listed and receiving *Technology Review* and our class notes. One of them, Jean Arnold, is happily remarried and is Mrs. Carl Beekers living in St. Louis. Jean, with Carl, attended M.I.T. Night at Pops and is still fond of M.I.T. '27ers and offered to coach English Croquet any time. Also at Pops were **Ezra Stevens, Nathan Cohn**, and **Laurence Coffin**. Larry's wife Helen, died last December, and he continues his job consulting program for serious at Maine Maritime Academy.

Last spring Gerry and **Fred Willcutt** enjoyed Disney World and a seven-day cruise to Grand Cayman, Jamaica, and Yucatan. . . . Ruth and **Joe Burley** spent a delightful overnight visit with Pat and **Dale Stetson** at their lodge-RR292, Warren, Vt. They reconstructed a tumble-down farmhouse 17 years ago into a warm attractive ski lodge with four suites filled with antiques and books they have collected from their previous travels. Dale was design manager for all stores of J.C. Penny Co. for many years and accepted retirement in 1965. They left New York for the rolling hills of Vermont, just one mile from famous Sugarbush resort in the Green Mountain Reservation.

Thomas M. Stetson was a post-grad architecture student in our class, previously Harvard, '24. He worked for several architecture firms in Boston and is now retired in Sandwich, Mass. He reports he has lost sight in one eye, and the other has low visability from glaucoma. He enjoys listening to records from the town library.

Your secretary has a chance to report some family events that are possibly typical in the lives of other classmates. Our granddaughter, Sarah Chase, received degree cum laude from St. Lawrence University in Canton, N.Y. Career undecided, she drove with two girls to the West this summer, plans course at Katherine Gibbs to learn a vocation. She resembles Brook Shields—grandfather recommends signing up with Hart Model Agency. Melissa Chase graduated Milton Academy, very active, organized personality, interest in everything particularly the young generation of other countries. Spent summer supervising and teaching 260 orphans at "Families for Children" in Dacca, Bangladesh. Wedding of nephew at College Park, Md. in chapel of University of Maryland. "Works" in consulting firm "think tank" for the Pentagon. Summing up, I conclude the next generation is far more diversified and prepared to cope with world affairs than we were.—**John C. Burley**, Secretary, 5 Hutchinson St., Milton, MA 02186; **Lawrence B. Grew**, Associate Secretary, 21 Yowago Ave., Branford, CT 06405; **Prentiss I. Cole**, Associate Secretary, 2150 Webster St., Palo Alto, CA 94301

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Our 55th Reunion was a tremendous success! The enthusiasm was evident from the very start as classmates and guests began to arrive on campus Wednesday, June 8, several hours before the designated registration time. Dorothy (Mrs. **Carney**) **Goldberg**, honorary reunion chairperson, and her hospitality committee (widows of '28ers) were all ready and waiting with snacks and refreshments for the incoming travelers. This country kitchen event was Dorothy's personal contribution and was done as a memorial to Carney. From then on there were five days of warm friendliness and pleasant activities that passed all too quickly.

We had a total of 141 registrants of whom nearly all were there for the full program. It would take a lot of writing to give anything like a full reunion report, but here are some of the highlights: Nearly everyone stayed at McCormick Hall. The **Bill Carlisle** Social Hour and the dinner dance on Wednesday evening provided a wonderful opportunity for attendees to get reacquainted and to catch up on news and gossip. Did anyone dance? You must believe it—and to a live music ensemble!

Thursday was spent away from the Institute. We traveled by bus to visit the Kennedy Memorial Library on the waterfront just south of Boston, then to the seaside town of Swampscott north of Boston for a very fine lobster lunch. Dr. and Mrs. Paul Gray '54, were our luncheon guests. That evening we had dinner at Symphony Hall in Boston followed by Tech Night at Pops with John Williams conducting. Later, back at McCormick Hall, members of '78 joined '28ers for a novel post-Pops singalong combining voices that spanned a half century. Beer and snacks were there to help.

Friday was Technology Day on campus and we joined in the general activities. Immediately after lunch and while we were all together, the 55th Reunion picture was taken in color and in panorama. With so many red jackets, the result was simply gorgeous. The class meeting and dinner was held Friday evening at the Faculty Club where the principal item of business was the installation of Shirley Picardi, secretary of the Alumni Association, as an honorary member of the class.

Saturday began with a bus tour of the M.I.T. Campus. We then continued on to Endicott House in Dedham for a pleasant lunch and enjoyment of the magnificent house and grounds. In the evening we had our final dinner party at the Boston Museum of Science. It was a memorable occasion that started with a social period in the inviting expanse of the museum's whole west wing. Then there was a dramatic demonstration with the M.I.T. Van de Graaff electrostatic generator. Dinner was served in the Museum's Skyline Room. It was a beautiful evening so that our twilight view of Charles River Basin with lighted buildings in Boston and Cambridge could not have been better. We had no scheduled speaker but the PA system and microphone were left open for anyone who might wish to address the class. Many took advantage of the opportunity to express personal views or to sound praise for M.I.T. and '28.

Sunday was the day of farewells and departure. Many left saying it was the best '28 reunion ever. The foregoing account would be lacking if we did not mention that a number of classmates came from afar. The prize for longest distance went to **Shikao Ikehara** who traveled from Japan. Then there were **Gabe Disario** from Venezuela, **Hector Hagedorn** from Spain, Nella and **Leonardo Siller** from Mexico, **Chuck Carter** from Canada and **Rene Simard** also from Canada.

Several messages have come to us since the reunion. Mostly they have been notes of appreciation. One from Shikao says that he will spend some time in the U.S. before returning to Japan. . . . Marjori and **Al Puschin** wrote to explain that they were unable to be in the group picture because Al had to hurry off to a business engagement. . . . Mary and **Max Parshall** were unable to be with us in Cambridge but they did send moral and financial support and we sent them the memorabilia items. Color snapshots enclosed with their letter shows them looking well together and Max is still just as handsome in his cardinal and gray ensemble. We have had several requests for replacement of lost or missing identification lists for the 55th Reunion group picture. A copy of the list was mailed with each picture. If yours is missing, let us know and a duplicate will be sent.

We regret to report the deaths of two classmates. **William A. Harris** died April 27, 1983. The information was provided in a note from his home in New Jersey. William was with our class as a graduate student in Course VI, electrical engineering. Our record shows that he was an engineer with RCA during his active years. . . . **Charles E. Gewertz** died April 20, 1983 in Vasteras, Sweden. He received his S.M. and Sc.D. degrees in the Department of Electrical Engineering. To the families of these classmates we extend our heartfelt sympathy.—**Walter J. Smith**, Secretary, 37 Dix St., Winchester, MA 01890

29 55th Reunion

I received a note from **Wesley Walters** and wife Josephine of St. Paul, Minn. saying, "Thank you for the birthday greetings and that thoughtful 'Salutation to Dawn' poem. Thank you also for such a wonderful job you are doing as class secretary. Today (May 23) is our 54th wedding anniversary. We now have three great grandchildren. We still do considerable hiking and traveling." . . . **William E. Lowery** of Plymouth, Mass. writes that he is still active in town government and other community affairs, such as town meeting representative and member of the Republican Town Committee. He is doing some re-reading of such classics as *Alice in Wonderland*, *Around the World in Eighty Days*, and Agatha Christie's mystery novels. He and his wife Charlotte continue to enjoy good health and are sending their greetings to all . . . **Fleming R. Hurt** of Waynesboro, Va. writes that he had three big events this summer—went to York, Pa. for the wedding of his first grandchild, then to Hampden-Sydney College for the memorial services of his roommate, and to Roanoke, Va. for the 90th birthday celebration of his brother. He hasn't recovered from the ordeal yet. He is retired since 1970, a practicing architect since 1934. He wants to know who is coming for the 55th. As a footnote to that question, I would say that there is a great deal of interest on the part of our classmates who are planning to attend our 55th which is only eight months from the time you read these lines. The Class of 1928 had 138 attending their 55th Reunion at M.I.T. Let us see if we can better that record. . . . In appreciation of my birthday greetings, **Joseph H.**

Durkee of Jacksonville, Fla. sends news of himself. Joe was stricken with polio in 1929 which left him paralyzed from his waist down. He gets around by the help of two canes. He has been retired since 1972 from business after 33 years. He is somewhat restricted in traveling but gets around in a wheel chair and even drives his specially equipped car. He and his wife Kathy are enjoying their retirement.

A note from **Charles Frank, Jr.** of Waltham, Mass. states that he is enjoying life with his new wife Corinne and her wonderful family. Recently, they had a dinner party at the Chateau Restaurant in Waltham where there were four generations represented. He is still active, serving on the advisory boards of the Red Cross and the Salvation Army. He is vice-president of the Kiwanis Club, a member of the Retired Men's Club of Newton and the Golden Age Club of Waltham. . . . **John D. McCaskey** of St. Joseph, Mo. has volunteered as a teacher and a guide in the local Elderhostel this summer. . . . **Richard E. Bolton** of Canada writes, "What a wonderful class secretary you have been over the years. I had my 76th birthday on Sanibel Island, Fla. and looked forward to receiving your cheerful greeting on my return home. Due to my wife's poor health, we do not get about very much and I miss my professional life which kept me in touch with good friends across the country. However, my son, who is in charge of the fusion research project at Hyda-Quebec and N.R.C., tries to keep me up to date. I continue to do some consulting work and I am a member emeritus of our local architectural and planning commission. The possibility of attending the 55th Reunion at Chatham has not been entirely eliminated. How I would like to get there even though all my close friends and classmates are now dead! The dean of Architecture and Planning is to be commended for his approach to his alumni. Of course, he will get some pretty strange replies to his request for comments on architectural education, including some ideas from me which were somewhere out in 'right field' as they say. I am most grateful to the Institute and to William Emerson (the dean) in particular for teaching me how to continue to educate myself during the last half century. Best regards to all."

I regret to announce the death of the following members of our class: **Alwin E. Rigg** of Old Greenwich, Conn., on April 5, 1983; **Clayton F. Jarvis** of Amesbury, Mass. and Sarasota, Fla. on May 13, 1983; **Lloyd W. Vickery** of Blackwell, Okla. on June 2, 1983; and **Owen R. Garfield** of Lakewood, N.J. on June 30, 1982. Clayton had a distinguished career in architectural engineering field, having worked for E.B. Badger Co., Stone and Webster, Arthur D. Little Co., Fay, Spofford and Thorndike, and General Services Administration prior to his retirement some ten years ago. He paid your secretary a visit some years ago, when he lived in Amesbury, Mass. during the summer months. We spent a delightful afternoon together. He was in ill health in recent years and went totally blind a few years ago, which broke his spirit. He was a member of the M.I.T. Club and E.B. Badger Retirees Club of Florida.

A few weeks ago, I received a telephone call from **Dexter Osgood**, Malverne, N.J., our class agent, informing me that he had a call from **Renato D. Fracassi** of Middletown, N.J. informing him that **Owen Garfield** had passed away that morning. He had been hospitalized for two and a half years. According to Dexter, Owen was a generous and regular contributor to the Alumni Fund, and had made a substantial donation to M.I.T. shortly before his death. His grandson, Peter Garfield has just completed his freshman year at M.I.T.—**Karnig Dinjian**, Secretary, P.O. Box 83, Arlington, MA 02174

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This was a red letter month in that communications came in from two classmates, **Bob Jacobs** and **Jim Keeley**, who had not previously responded during my 23-year stint as secretary. Bob Jacobs retired several years ago after a 35-year career as a civil and mechanical engineer with Stone and Webster Engineering Corp. During World War II he spent a few years at Oak Ridge on the Manhattan Project and as a result of this experience "got in on the ground floor in nuclear power," specializing in nuclear concrete containment design. He was active in the Power Division of A.S.C.E. and also maintained contact with the Institute by consulting frequently with M.I.T. professors Biggs and Halley on nuclear containment structural matters. His "swan song" was managing the design, engineering and construction of the new Stone and Webster headquarters building in Boston. At the time of his retirement he was engineering manager, senior vice-president and a director of Stone and Webster. Since his retirement Bob and his wife, Barbara, have spent winters in Florida and done considerable travelling, but have "always managed to get back for the New England golf season which we both enjoy." . . . Jim Keeley is one of our five patent examiners. After receiving a J.D. from George Washington University, he spent his career in the U.S. Patent Office, except for about six years in the U.S. Army Signal Corps during World War II. In due course he became one of the chief examiners who comprise the Patent Office Board of Appeals, a tribunal that hears appeals by patent applicants from adverse decisions of the primary examiners. After retirement, Jim initially did some consulting work in the patent field but found that it interfered too much with his other retirement interests.

Last spring **Morris Shaffer** and his wife made a trip around the world, during the course of which they visited China as part of an "infectious disease delegation." . . . **Merritt Hulett** and his wife, Marjorie, now live in Rockport, Texas. For most of his working years Merritt was self-employed in the fields of hospital management, U.S.D.A. government contracts, military research and lime and limestone production. His retirement hobbies include antique furniture restoration and working on the A.A.R.P. federal income tax aid program. . . . We have a breezy report from **David "Tul" Houston**, for whom everything seems to be going very well. Tul has turned over the operation of David T. Houston Co., Industrial and Commercial Realtors to David Jr., who "is now president and chief executive officer and doing a great job, running the company very successfully." Last January, Tul and Anne moved into a new home on Hilton Head Island which he ecstatically describes as "the cream of all our previous homes and collections of ideas" and a "real dream house, facing Port Royal Sound, with a screened-in pool, and surrounded by magnificent tall pines." It even includes a private office for Tul where he can "pretend to work." The new house has attracted so many visitors that the Houstons are thinking of hanging out a "no vacancy" sign. M.I.T. visitors returning north from winter homes in Florida include Mau and **Herm Botzow** on their way from Stuart, Fla., to Hinckley, Ohio, and Cynthia and **Bob Reynolds** on a transit from Delray Beach to Centerville, Mass. Tul is a director of the Hilton Head Island Community Association and the Dolphin Point Club Homeowners Association, as well as a member of a committee for incorporating Hilton Head Island as a town. His hobbies include "golf, sailing a 23' sloop, swimming, elbow bending, watching the boats and dolphins go past our beach and collecting checks."

We have at hand delayed notices concerning the deaths of two more of our classmates: **Rollin Rosser** on January 8, 1982, and **Eugene Silva** on October 28, 1982. Unfortunately, I do not have any information at all about Silva. . . . Rosser practiced architecture in Dayton, Ohio, for a considerable number of years. He was at one time president of the Architect's Society of Ohio and of the Montgomery County Planning Commission. As of 1974, the most recent report in my files, he had a wife Eloise, a son who was an architect, a second son who was a lawyer, two daughters and six grandchildren. He apparently died in a fire that completely destroyed his Dayton home.—**Gordon K. Lister**, Secretary, 294-B Heritage Village, Southbury, CT 06488

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The Sitmar Cruise to Alaska for our Mini-Reunion turned out to be a perfect selection. Everything went perfectly, the food and service couldn't have been better—and all of us who took side trips thoroughly enjoyed them. The best part of all was meeting our fellow classmates and their wives and friends. Among our classmates who attended were: the **Ashendons**, the **Binners**, **Ken Bolles** and a friend, the **Eugene G. Brancas**, the **Joseph Buswells**, Polly and **Ken Germeshausen**, the **Arthur Newells**, the **Enio Persions**, the **Robert Sanders**, the **Al Sims**, the **Whitakers**, **Myrle Perkins** and friend, and yours truly and his better half. **Tinsley Rucker** was scheduled to join us, but unfortunately he passed away in March; Ms. Minna Corbin and Ms. Edith Carpenter, friends of the Ruckers, came in the place of Tins and his wife, Lorrell. Even though Helen talked me into joining the dancing class, I enjoyed every minute of the cruise. Perhaps the most lasting memory will be the flight we took into the Crater of St. Helens in Oregon.

During the cruse, I took the opportunity to have some of the fellows bring us up to date on their careers. The information follows: **Randy Binner** retired in 1973 as vice president and chief engineer of the Great Lakes Carbon Corp., N.Y. He continued with the same company as a consultant until 1982. He has a continuing interest in curling and community affairs. . . . **Ken Germeshausen** writes, "The cruise to Alaska was fabulous. Everything was up to expectations and on schedule; no luggage or passengers were lost. All 13 classmates and wives attending were enthusiastic and wanted to know what we could do for our next reunion. One of the benefits most talked about was that it gave us a chance to talk to each of our classmates in depth and find out what they had been doing for the last 53 years. As for myself, after graduation I joined Doc Edgerton in a consulting partnership to use the high-speed photography and stroboscopic techniques for the solution of industrial problems. Business was good, so **Grier** joined us in 1934. I was made a research associate at M.I.T., without stipend, a position I still hold emeritus. When the war came, we each went our separate ways. I joined the Radiation Lab and later became involved with nuclear weapons development at Los Alamos. In 1947 we got together again to found EG&G, Inc., where I was successively treasurer, president, and chairman. I'm now retired as chairman, but I'm still a consultant to EG&G and a member of the business development committee. EG&G is now in the Fortune 500 with sales of over 800×10^6. At M.I.T. I am a lifetime member emeritus of the Corporation and member of the Council for the Arts. In addition I am a member of the Corporation of the Franklin Pierce Law School, and active in town affairs. So you can see, I am reasonably busy."

Elliot Whitaker writes that he recently retired from Ohio State University after 33 years of teaching and administration in the School of Architecture. Now he and Doris are engaged in many of the more esoteric things in life—grandchildren (four of them), amateur philately, travel and community affairs. Life ahead, he says, looks great. . . . **Al Sims** reports that after a very slow start in that not-very-good year of 1931, he ended up with a textile company in Rhode Island and spent the next 22 years there. Due to the migration of textiles South, he was without a job in 1955; after a few rough years he was rescued by a civil service exam and ended up in the Air Force Base Lab for the next 17 years of his work experience. In 1974, he retired; in 1975, they decided to spend winters in Florida. Now it's Rhode Island in the summer and Florida in the winter. . . . **Ken Bolles** retired from Simplex Wire and Cable Co. in Cambridge, Mass., after 35 years of employment—six years as an electrical engineer, the remaining as personnel director. At present he is living in Brockton; he has thought of retiring to Florida but decided that he is happier staying in New England. His principal activity is golf. . . . **Bob Sanders** retired from Sanders Aviation (manufacturer of Ercoupe airplane) and from F.A.A. as con-

sultant. He was in aeronautics, including Naval Aviation, his whole working life. He retired as Commander after World War II. He and his wife, Emily, seem to be enjoying their retirement.

Enio Persion and his wife Loretta, retired in 1981 after helping to build many buildings in the Washington, D.C. area with one of the large contractors, and have enjoyed retirement very much. They enjoyed the M.I.T. Quarter Century Club Yugoslavia trip two years ago, and they travel every chance they get. In addition, they enjoy their five grandchildren. He also comments, "This Alaska cruise is the ultimate—fine friendships, good food and beautiful scenery." . . . **Joe Buswell** writes, "In my 18th year of retirement after working 33 and a half years for Uncle Sam Bureau of Standards, Bureau of Reclamation and Corps of Engineers." His latest travels include South Korea and Indonesia and heli-hiking in the British Columbia Cariboos. . . . Mary and **Eugene Branca** say that Gene retired 10 years ago, and now they winter in Florida with summers in Humarock (South Shore). He also says, "Having a terrific time in Alaska." Art Newell mentioned that he wanted to go to Southern France but his wife, Sally, wanted to go to Alaska. He adds, "An excellent tour with the very best of companions." . . . As you can readily see from the above comments, Polly and **Ken Germeshausen** made an excellent selection when they picked the Sitmar line for the cruise.

A letter from **Emile Grenier** reports, "I have good news and bad news. The good news is that I am now once more well and strong enough to spend as much as three hours at a time walking behind my self-propelled lawn-mower, which I do when the lawn is too soft to allow the use of my riding my Snapper mower. The bad news is that in February the doctor finally decided that the 36 radiation treatments had not eliminated the cancer in my larynx and so he operated and removed it. I was in St. Josephs Mercy Hospital for about 17 days and ran up a bill of about $20,000—which fortunately was covered by my insurance. I am now able to talk using a vibrator type of device called Servox, made by Siemens in Germany. It sends a sound wave into the throat when pressed against the outer surface of the throat and then I modulate the wave to create words. I may be able to learn to speak without this device later on using what is called esophageal speech, where one learns to draw air down into the esophagus and then lets it back while again modulating it. I go to a club consisting of people who have had their larynx removed and most of them can speak very well this way. My daughter, Sally Ann Moses, (my only child) who teaches gifted children in the Hillsdale, N.J. school system, entered a group of her children in the contest called the Olympics of the Mind. They won the New Jersey state championship in late April, which made them eligible to compete in the world championships; Sally's group won first prize. The Hillsdale board of education had voted Sally Ann an Honorarium of $500 prior to this competition in recognition of her considerable amount of extra effort in this project. They also voted $4,000 to cover expenses for the trip. . . . I am still waiting to find out just what the Supreme Court will decide on the appeal of the U.S. Government of the U.S. Court of Appeals decision to reinstate the passive restraint mandate. I have twice written to all members of the court giving them complete documentation of the fact that both the air bag and the passive belt systems are potentially lethal. I trust that they will reverse the Appeals Court." I know that all of Emile's classmates wish him the best of luck. . . . **Paul Semple** writes that he attended the high school graduation of his oldest granddaughter, May 27. She graduated with honors and will attend Illinois College in the fall. His son Richard retired as a Lt. Colonel from the Air Force and is now living with his family in Spokane, Wash.

Our 55th Reunion Note: Word from **Dave Buchanan** is that Clare and **Ben Steverman** have accepted the chairmanship of the 55th Reunion, for which they have a tentative commitment at the Wychmere Harbor Club at Harwichport, Mass. As you may recall, we voted at the 50th to have our fun time after the festivities in Cambridge rather than before, so this will be June 7-10, 1986. Ben will be asking some of the fellows in the vicinity to help on his committee, and we all hope they respond favorably.

Arnold Childs writes, "Rita and I spend six months on Siesta Key in Florida and the six summer months in Thornton, N.H. One son is with Metropolitan Life, and we see him and his family frequently. Our second son is a missionary in Nigeria with his family there. We now have one grandson." . . . Word from **Howard Huntress**: "I keep up my good relationship with Abex Corp., from which I retired in 1974. Up to 1973, we traveled around the U.S., Hawaii, and Great Britain, and took an eclipse cruise into the Atlantic. In 1979, we had a three-week cross-Canada tour. Now we limit our traveling to visiting our children in Massachusetts, North Carolina, Ohio and Washington. Still singing, though practically deaf." . . . **Fred Elser** sent his regards to his classmates on the Alaska cruise and mentions that about June 1931, after graduation, he took a steamer up there from Vancouver, B.C. as far as Skagway and White Horse. Fred and Mardy are coping with the aid of large bottles of pills from the Tripler Army General Hospital near them.

Following is the sad news that I always feel sorry about reporting. Although **Joseph Richard Brennan**'s death was reported earlier, his wife, Jane, has sent me the following additional information: Joseph Richard Brennan, native of Somerville, Mass., died suddenly at his home in Alexandria, Va., on November 5, 1982. He was employed as a civilian engineer for over 20 years with the U.S. Army Corps of Engineers, first in Los Angeles, and later as chief of Project Planning Branch, Civil Works Division, Office of the Chief of Army Engineers in Washington, D.C. In 1957, he became the staff engineer consultant to the Committee on Public Works, U.S. House of Representatives, dealing with the authorization of nationwide programs for water pollution control, flood control hydroelectric power, rivers and harbors, and the international highway system. He was author of several government publications and articles, and was a registered professional engineer in the District of Columbia. He is survived by his wife, Jane Mansfield Brennan, two daughters, Joan Crosby of Spokane, Wash., and Mary Stowe of Redding, Calif., three grandchildren, and a brother Paul R. Brennan of Boston, Mass. . . . As mentioned earlier in these notes, **Tinsley W. Rucker** passed away on March 20, 1983. He had planned on joining us on the Alaskan cruise. . . . **Judson M. Miskimen** passed away on June 12, 1981, although the Alumni Association was not notified until June 13, 1983. No further information has been received regarding Tinsley Rucker, Judson Miskimen, or **Hugo Kleinhans, Jr.**, who passed away on March 11, 1983. . . . **James J. Byrne**, who retired as director of the engineering division of the U.S. Forest Service, died March 19 in his home after a heart attack. He was a 1967 recipient of the Agriculture Department's superior service award for his work in forest engineering. He was born in Idaho, a graduate of Montana State University and earned a M.S. in electrical engineering at Tech in 1931. . . . Our sincere condolences to all of their families.

Last but not least, these notes would not be complete without quoting a letter **Dave Buchanan** sent to Polly and **Ken Germeshausen** just before the Alaska cruise: "Just a note of greetings to the Thirty-Oners and our most sincere thanks to you, Polly and Ken, for arranging this very special trip to the 49th State. I am sorry that Dorothy and I are not there to greet you personally. We know that you are going to have a great time with untold scenery upon which to gaze and wonderful companionship within the group. Our thoughts will be with you daily, and we have some idea of what you will be seeing and doing. We had the good fortune to take the North Cape cruise a few years ago, in and out of the fjords of Norway, seeing mountains, glaciers and the like. We also know that you will not have any trouble sleeping even if the sun is shining. Hope that you have wonderful weather, not like this spring in New England, with rain, rain, rain and then sleet and snow after the middle of May. In my absence I am asking Ken, our honorary president, to bring these greetings to you. We are sure that you will have a marvelous trip and we will look forward to getting together with all of you for the 55th in '86." You are right, Dave, it was a wonderful trip.—**Edwin S. Worden**, Secretary, P.O. Box 1241, Mount Dora, FL 32757; **John R. Swanton**, Assistant Secretary, 27 George St., Newton, MA 02158; **Ben W. Steverman**, Assistant Secretary, 3 Pawtucket Rd., Plymouth, MA 02360

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The weather was beautiful on Technology Day in June. I had a good opportunity to talk with the following classmates who were able to attend: **Wendell Bearce**, **John Brown**, **Albert Dietz**, **Richard Lobban**, **Douglas Miller**, and **Thomas Weston**.

The memorial service for M.I.T. alumni was impressive. The members of our class that were reported deceased from April 30, 1982 to April 29, 1983 are as follows: **Clarence M. Chase, Jr.**, **Joseph T. Cimorelli**, **Meir H. Degani**, **Thomas F. Duggan**, **Thomas P. Dunleavey**, **Frederick P. Fay**, **Donald W. Fetters**, **Christian E. Grosser**, **Addison S. Hall**, **Alfred W. Halper**, **John T.R. Nickerson**, **Alfred G. Reidell**, **William B. Schneider, Jr.**, **Albert A. Stewart**, **William L. Steiglitz**, **G. Jack Stover**, **Carroll L. Wilson**, and **Manley M. Windsor**.

Albert Deitz makes the news again. He is the chairman of a conference on reducing housing costs to be held in August at New England College. All aspects of the problem will be studied and hopefully the recommendations made will have a significant impact on the development of affordable housing.. . . **James Smith** is still very active as a consultant in the field of fire protection. Recently he was invested with the grade of felllow in the Society of Fire Proection Engineers (SFPE) in recognition of significant accomplishment in his field.

Richard Stewart's story is a most interesting one, especially to those trying to get their careers started in hard times. In 1932 a group of college technical men were tired of sitting around doing practically nothing. Acting as spokesperson for the group he advertised that they were ready to offer their technical services for "just the sweet pleasure of working on technical projects." The publicity was responsible for his getting a job with Anaconda American Brass Co. Thirty-five years later he retired as chairman of the company. He is now busy with many hobbies. One of his most recent has been the discovery and restoration of a steam car built in Quebec in 1867—Canada's first automobile. The car is now on permanent exhibition at the National Museum of Science and Industry in Ottawa. He reports he and his wife, three sons, and eight grandchildren are all well. They have much to be thankful for. . . . **Stewart Phillips**, a confirmed bachelor, tells of his month-long vacation trip in Australia. It was a primitive, close-to-nature camping trip that took him to the rim of the crater in Hawa, Maui. The scenes were magnificent.

I must report that **Henry T. Smith** died on March 1, 1983 after a long illness and that **Robert W. Baschnagel** died on September 10, 1981. When I receive further obituary information, I will pass it on.—**Melvin Castleman**, 163 Beach Bluff Ave., Swampscott, MA 01907

33

The great Class of 1933—and we're not bragging! —attended our 50th Reunion at Cambridge and Cape Cod in good numbers. Our retiring president, **Fred Murphy**, reported that 107 members of an original class of just over 600 attended one or more of the fuctions coordinated by **Clarence Westaway**, our perennial reunion chairman. Almost 100 wives also attended.

Our Alumni Fund chairman, **Dayton Clewell**, gave President Paul Gray a check for $3,650,775 at

Dayton H. Clewell, '33, (right) presents to President Paul E. Gray the 1933 50th reunion gift of $3,650,775, the second largest 50-year gift. ***(Photo: Scott Globus, '84)***

the alumni luncheon and in addition announced that **Cy Haygood** had $2,586,000 of bequests to add to that. Murphy presented a citation to our 23-year veteran secretary **Warren Henderson** for faithful service. He is now our secretary emeritus.

This was a reunion with a different feeling, as Daphne Whitton said: five and ten years ago we were thinking of how to finance college educations, deciding what to do with our businesses, and considering when to retire. With most of this behind us there was a happier, freer air in the group. Many have retired, but not all. **Jim Norcross** in Philadelphia started a consulting service for home owners; **Frank Der Yuen** has opened an inter-island communication company in Hawaii after being with Aloha Airlines until retirement. **Fred Kressman** says he will soon have pulled all the pine stumps in Florida to make into turpentine and will retire.

Chuck Fulkerson brought the largest delegation—variously reported as 7 to 10, including little Heidi who in 1963 was showing folks how to open lobster claws with a Coke bottle.

We're sorry to report six deaths this year: **John Dahlberg, William Adams, Jr., John J. Cashman, Jr., John T. MacIsaac, Jr., Gentil P. Reyntjens,** and if we haven't chronicled it before **George Huff**.

It was a wonderful time of good fellowship and happy recollections. Our new class officers are **Dick Morse**, president; **Dick Fossett**, vice-president; **George Stoll**, treasurer; and **Beau Whitton**, secretary for the moment.

We wish we could mention everyone, but this is all the space allowed. As the old time movie serials said "continued next time."—**Beaumert Whitton**, Secretary, Cottage 112, Sharon Towers, 5150 Sharon Rd., Charlotte, NC 28210

34

After a two-to-three-month hiatus, it's been hard to get back to work, especially when most of the information I've got is depressing. There seems to have been a spate of losses happening, or coming to light, in the last few months. Almost equally unfortunate, in my mind, is the time that has elapsed in some cases which indicates how tenuous is our connection with some classmates. Some of the following names appeared among the "deceased" in the July *Review*—in fact, for two of them this is the only information I have.

Glenn J. Baker died in Calabasas, Calif. on August 15, 1980. . . . Our next loss was **Franklin C. Safford** of Huntingdon Valley, Pa. on May 11, 1981. His son, Gray C. Safford, '75, writes that his father's death came after a long battle with cancer. . . . **John C. Turnbull**, who received his Ph.D. in physics with us, died in Lancaster, Pa. on May 4, 1982. . . . There is no information about **Edward D. Rich** except that he died in Ventura, Calif. on March 9, 1983.

Here on the Cape our class family was diminished when **Ray Jewett**'s wife, Olga, died in May. This was a personal loss since Olga and my wife Jane had been classmates at Simmons and we had been together at many M.I.T. club affairs here on the Cape. Fortunately, their children's Christmas present had been a trip West for Ray and Olga to see their son and daughter, so there was a family reunion before Olga's final illness.

Our final loss to report is that of **Lester Tarnopol** on June 1, 1983 in San Mateo, Calif. He was one of those people who seem to have major changes in career fields. He had taken S.B. and M.S. degrees in science at M.I.T. and then received a doctorate at Harvard in physical metallurgy. But he eventually became highly involved in learning disabilities, and at the time of his death he was an international expert in this field. He had written nearly 100 books on psychology and engineering and five on learning disabilities. A professor at San Francisco City College for 30 years, he had retired in 1978 but continued as a consultant with Risk Consultants in San Mateo. Dr. Tarnopol is survived by his wife Muriel, a brother, three sons, and a daughter. To all the families involved in these unfortunate losses, I extend the sympathy and condolences of our class.

Some time ago I mentioned some correspondence with **George Huff** from Argentina. When we got home in the middle of June there was a letter from him. In the summer of 1982 he made his planned trip to the United States, mostly on Long Island. He says he had a brief, enjoyable stay on Martha's Vineyard, but because he wasn't able to make a hoped-for auto trip to New England, he didn't have a chance to stop by in Brewster.

Ben Salmon writes, "Retired from Carpenter Technology Corp. on December 22, 1975 as director of nuclear product development. Was grand master of the Grand Council Cryptic Masons of California in 1970 and eminent prior of Los Angeles Priory No. 27, Knightly York Cross of Honor in 1981. Had congestive heart failure in April 1980 and am much restricted in activity of any sort." (Restrictions of that nature can be very frustrating; it was the prospect of such limitations that reduced my qualms in 1981 about the bypass surgery that has been so successful for me.)

Fred Vaughn sent a postcard. He's still job-hopping apparently as he says, "After starting and managing my own paper box manufacturing company I retired from it after 25 years. I am now teaching at the Fashion Institute of Technology in New York City. I teach package engineering to seniors working for their BFA in packaging design. The vitality of this great country of ours depends on the creative and the enthusiastic. There are plenty of them there!"

In the July notes I commented that I had warned our friends in England to get rid of the bad weather that had been plaguing them all spring before we started on our trip. Well, they didn't quite make it; witness the fact that in seven weeks in France and England I shot only five rolls of film. We had a pleasant five days in Paris. We went first to Tours and revisited some of the most attractive of the chateaux. We also visited cathedrals in Bourges, Reims, and Rouen, and along the way stayed outside Dijon at an attractive little hotel in the Burgundy wine district.

We crossed to England on the Hovercraft. This year I managed to stay on the correct side of the road for all the 1,500 miles we covered. In England we had pleasant visits with friends, including two couples we had met last year in the hotel in Torquay, Devon. In both cases they showed us around their own areas—one in the Thomas Hardy country in Dorset and the other in Bath. We got to see several cathedrals. They are such marvelous examples of architecture and construction, and the realization that parts of what you are looking at is 600 or 700 years old gives you duck bumps! We had a day at Coalbrookvale which is being restored as a museum of industrial archaeology spread out over about six square miles. Finally, at long last we made it to North Wales, saw some lovely scenery and the magnificent remains of Conway and Caernarvon castles.

By now you should all have received mailings about next year's reunion. Even if you are undecided about coming, send in the history sheet (and the class dues that will assure you a copy of the book that is to be put together). I think the program that's shaping up will be an interesting and entertaining one. We will be staying in the McCormick Dorms—the committee made an inspection trip through them and feel that people will be happier there than where we were in 1979. There was little interest indicated in the early replies about going to Bermuda, but there may be enough for a group to go on to the Cape.—**Robert M. Franklin**, Secretary, P.O. Box 1147, 620 Satucket Rd., Brewster, MA 02631; **George G. Bull**, Assistant Secretary, 4601 N. Park Ave., Apt. 711, Chevy Chase, MD 20815

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As I rush to meet the deadline for this issue we are in the middle of July with the best summer weather we have seen here for years it seems. The winter and wet spring lasting through May has dulled my memory.

Sam Brown writes, "We sold the Short Hills, N.J. home so fast that it made us rush to vacate on May 27. In May I retired from the board of directors of Kaiser Steel Corp., so my frequent and often short-notice trips to the West Coast are terminated. Our condo in Florida is rented through December 1983, so we will be nomads down there this fall, but our P.O. Box 77, Punta Gorda, FL 33951 address will be checked frequently for mail. We have joined Burnt Store Golf and Racquet Club in Punta Gorda, and for one year I am continuing a non-resident membership at Canoe Brook. . . . At M.I.T. June 8-9 we attended Pops and the Friday "A-1" session, but we left before lunch to drive westward. Next year we may come earlier and stay longer."

Sam's note on Technology Day is a prelude to the biggest and best news for our class since I began writing these notes 23 years ago. **Randy Antonsen**, the former class bachelor, introduced Constance, his new attractive wife, to all who would stop and listen. She will make a lovely addition to our future reunions. I fully expect attendance at our 50th will set a new Class record!

Leo Beckwith's daughter Carol is having an excerpt from her book, *Nomad's Niger*, published in the October 1983 issue of the *National Geographic*. Don't miss it!

I am happy to pass along a letter which **Walter H. Stockmayer** says is his first in seven years. "Sylvia and I are both well, barring the usual aches and pains and still do a lot of tennis and hiking. I haven't been in an eight-oared shell for about four years because I can't get enough other faculty to come out. But I promise to be ready for our 50th anniversary row in 1985! We have gone to Europe quite a lot. In 1978-79 we spent eight months in Freiburg, Germany. I went just to do research, but my German host had a heart attack and I had to take his graduate course lectures (in German!) because the only other possible substitute was away for the term. The students knew enough English (scientific words, that is) so I got by, and it was really rather good fun.

"In 1979 I reached age 65 and the retirement age then was still 65, so I became officially a professor emeritus. But I have kept on working—still teaching two-thirds of a full load, doing research and helping edit *Macromolecules*, an ACS journal. I don't know where the other one-third time went—obviously Parkinson's Law is working. I still love the work, and of course the contact with students keeps one young. Research is going reasonably well though a little slower, and my NSF grant has been extended at least through 1984." To avoid elimination of paragraphs (called editing), I am going to continue Stocky's letter in the next issue, along with letters from **Les Brooks** and **Dexter Clough**. It's great to have a small backlog and I surely ap-

preciate all the mail as I am sure you do.

I am sorry to report the deaths of Brigadier General **John H. Weber** on January 17, 1983 and **Richard H. Cook** on April 14, 1983. John Weber received his M.S. degree in ME with us and lived in Midlothian, Va. **John Cook** retired after 35 years with the Foxboro Co. and lived most of his life in Norwood. I am sending expressions of sympathy to the surviving daughter and widow respectively on behalf of our class members.

I would like to end with some rather fantastic news of my own. After 18 months and three trips to England, Simon Relays U.S.A., Inc. is organized and settling into its plant in Nashua, N.H. This is my 12th start-up, all in various areas of electronic manufacturing, except for one disaster into publishing. Nine of the previous 11 are still going! This one has a once-in-a-lifetime opportunity. The product is an energy-saving electric motor controller for three-phase 60-hertz induction motors of 10 horsepower up, developed under a British Government grant and patented worldwide. We are the sole American sub-licensee of Simon Relays Ltd., a prime licensee of the British Trade Group. Unlike other energy saving units put out by Reliance/Exxon and several others, this one really works and has been used in the U.K. for the last one-and-a-half years. NEMA estimates the market at 100,000,000 motors (applications) translating into about $75 billion. We will manufacture here incorporating a small part we shall buy from the U.K. In two weeks of effort we have put almost $1.75 million on the books and will not make our first shipments until August 1983! We are going to remind people of Apple Computer's Skyrocket! Our early $5.5 million first-year forecast looks six times short!—**Allan Q. Mowatt**, Secretary, P.O. Box 92, Newton, MA 02195

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A handful of '36ers attended some of the Alumni Day activities. The usual Boston-based contingent were at the luncheon. Rose and **Ed Dashevsky**, Rosalie and **Jack Chapper, Leo Kramer**, and I were joined by Florence Cooperstein who had come for the memorial service which precedes the luncheon.

Another stalwart has announced plans to retire. After 47 years as manager of the Allentown-Bethlehem, Easton Airport, **Wiley Post** is going to relax! During his time, the airport has progressed from a grassy strip to a "modern multi-million dollar facility."

If you find that you can be in Connecticut on Saturday, October 29th, get in touch with Mary and **Fred Assmann** (17 East Curlis Ave., Pennington, NJ 08534) or if at the last moment directly with me at (203) 379-3807.—**Alice H. Kimball**, Secretary, P.O. Box 31, West Hartland, CT 06091

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Ed Corea wrote in May, "Got a note and a picture taken at our reunion at Martha's Vinyard with Anne and **Stan Zemansky**. They have been busy since they are in the midst of a move to California. I also just talked to **Joe Heal**. He is up from Florida and I saw Joe and Marion at our May 24 Senior Citizen Club meeting in Hingham. Joe was the entertainment and he was great. It was **Josiah Heal**, base baritone, who entertained with a concert that held about 100 seniors spellbound for one hour of continuous singing. Normally no one can keep us quiet for more than one-half hour, but Joe was so good that we didn't move. They plan to stay in Hingham, then go to Maine for the summer." . . . **Robert L. Adler** writes, "We moved to Garland, Tex., from southern California in August 1982. Continuing my business as consultant in oilwell drilling instrumentation. Business slow, but like it here in Texas."

Robert E. Hopkins, 49 Reservoir Ave., Rochester, N.Y., was recently awarded the second Joseph Fraunhofer Award of the Optical Society of America. The award will be presented to Hopkins this fall at the society's annual meeting in New Orleans. The Fraunhofer Award was established by the society in 1982 to recognize distinguished contributions to optical engineering. The Society cited Hopkins' many achievements in the field, including the design, development, engineering, and manufacturing of many important optical instruments. Among the instruments designed by Hopkins are lenses used in the Todd-AO cinematographic process, aerial cameras, laser scanning, and photolithography; several periscope systems; and infrared detecting devices. He joined the University of Rochester, N.Y. in 1945. He served as director of the Institute of Optics from 1952 to 1964. He was senior optical systems engineer at the University's Laboratory for Laser Energetics from 1975 to 1982, when he became professor emeritus.

Bertrand E. Bennison writes, "Retired from Florida's public health effort in 1981. Now enjoying life on Cape Cod. Between spurts of puttering on a real old house, I try to do a little writing, talk with interesting people, attend meetings locally and in the Boston area, visit our four offspring, and pursue miscellaneous hobbies." . . . **Frank J. Barrett** is still practicing his profession and maintains his own office. His other activities are architecture, travel, land development, water coloring, and book collecting. . . . **Richard Fuller** is doing medical research. . . . **Hjalmar D. Bruhn** writes, "I am continuing my research on the dewatering of alfalfa for production of top quality silage prepared without field curing and its inherent weather damage. The extracted juice will yield a protein suitable for animal and human consumption. I recently designed and built a small-scale set up in Mexico to extract such protein for a nutritional study of 50 children and 15 pregnant women."—**Lester M. Klashman**, Assistant Secretary, 198 Maple St., Malden, MA 02148; **Robert H. Thorson**, Secretary, 506 Riverside Ave., Medford, MA 02155

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Because of the time lag in publishing a monthly magazine, this is my first opportunity to report on our 45th Reunion. As was promised, the weather couldn't have been better. Ninety-eight appeared at Wianno, and 118 at M.I.T. Special thanks to **Haskell Gordon**, who could not attend, for the prizes. Croquet champ was **Ed Hadley**, and, don't try to putt against **Charlie King**—would you believe 29

Wilbur B. Huston, '33, and his wife, Dorothy, return to M.I.T. for his class' 50th reunion. Huston won a full-tuition scholarship when he was chosen "brightest in America" in a contest sponsored by Thomas Edison.

They Took Thomas Edison's Word: Brightest in America

When he graduated from high school in Seattle, **Wilbur B. Huston, '33**, wanted to come to M.I.T. But he didn't apply, because he couldn't afford the tuition—then $400—and the train fare.

But then he became one of 49 finalists—one from each state and the District of Columbia—in an unusual contest that the newspapers dubbed a search for "the brightest boy in America." Here's the story, as Mr. Huston told it to Robert DiIorio of the M.I.T. News Office during Huston's 50th reunion last June:

The contest judges included Thomas Edison, sponsor of the contest, Henry Ford, Charles A. Lindbergh, and Samuel W. Stratton, eighth president of M.I.T. And after a four-hour written examination, Huston was declared the winner.

"The prize was a full-tuition scholarship with travel expenses to any college of my choice," Huston recalled. And there was no doubt of his choice—M.I.T. But by then it was early summer, and "I was in a bind of sorts because I hadn't submitted an application to M.I.T."

"When I won, I said I wanted to go to M.I.T., and I guess the admissions people figured that passing that four-hour exam was good enough for them."

All that occurred in 1929, and four years later Mr. Huston graduated with a S.B. in physics.

Most of his career was spent working for the federal government, first as an aeronautical research scientist for the National Advisory Committee for Aeronautics and more recently, until his retirement from government service, as a satellite meteorologist with the National Aeronautics and Space Administration. Since 1975, he has worked with OAP Corp. of Greenbelt, Md., a high technology problem-solving group.

He lives with his wife, Dorothy, in Crofton, Md. They have six children.

Stanley M. Proctor, '43, (right) presents to President Paul E. Gray the 1943 40-year gift, a record-breaking $2,288,455. ***(Photo: Scott Globus, '84)***

putts for 18 holes!

Nominating committee chairman **Bob Johnson** proposed a slate with **Don Severance** as president, **Ed True**, treasurer, no relief for your secretary, and **Ed Hadley** as chairman of the reunion gift committee. Also voted was the formation of a class council (more of this later) and designation of Class of 1938 honorary member, **Hugh Darden**, assistant treasurer and director of planned giving at M.I.T.

Don Severance requests that those of you who have reunion pictures send copies to him in anticipation of a 50-year book. As a matter of fact, he is offering a prize for the best picture at Wianno. But, prize or not, please send copies of all reunion pictures, hopefully recording on the back class members and year. . . . Last thing on the reunion—Wianno was so enjoyed that, after a survey, Don has reserved Wianno for our 50th!

Now for the Class Council: this has been formed to make our 50th reunion gift in 1988 the largest in the history of the Institute. In the meantime, our new president, **Don Severance**, wants you all to know that every contribution from now till then will be credited to the 50th reunion gift, so give early and often. Contributions can include checks, capital-gain stocks, life-income funds, corporate-matching, and gifts by others credited to the class. Unless you have a special interest, make a note that it should go to "Class of '38 Fund." Present plans are to establish an endowment and/or revolving loan fund for student aid, badly needed in view of rising tuition costs.

Al Clogston retired from Bell Labs last year, but spends several days a week consulting at Los Alamos, and a lot of time working on committees for NAS, the Air Force and the Department of Energy. Al says the best part of retirement is that it gives him time to get back into research.

Bill McClenahan retired as director of Information Services, the Institute of Paper Chemistry, and keeps himself busy abstracting technical literature for the abstract bulletin of the Institute. . . . **George Stansfeld** retired this year as senior historian, HQ DARCOM, the Department of the Army. . . . Yet another retiree is **Ken Gunkel**, who retired from the Mexican subsidiary of Container Corp. Ken expects to settle near Tyler, Tex., and work on his golf handicap.—**Armand L. Bruneau, Jr.**, Secretary, 663 Riverview, Chatham, MA 02633

39 45th Reunion

Our 45th Reunion will be held June 4-8, 1984. So far, the format includes checking in late Monday afternoon, June 4, at the Harbor View Hotel on Martha's Vineyard, where we will stay through lunch on Thursday, June 7. Then we will return to the M.I.T. campus for a Pops concert Thursday night and Technology Day, including the awards luncheon, on Friday. Accommodation plans for Thursday night will be announced soon.

Seymour Sheinkopf, 205 Wolcott Rd., Brookline, MA 02146 is reunion chairman. Helping so far are **Ernie Kaswell, Fred Schaller, Aaron White, Joe Dana, Bob Pratt, Marty Lindberg**, and their ever-luvin' wives. The committee invites classmates to volunteer suggestions and man-hours of labor in kind. Each classmate will receive a letter with details. In the meantime let's block June 4-8 for fun.

Every now and then some classmate exposes me to a tremendous and extraordinary adventure. Today was one of those days, and I'd like to share it with you. You may remember a year ago **Ernie Kaswell** was invited to present the Edward Robinson Schwartz Memorial Lecture before the Textile Division of the American Society of Mechanical Engineers. Today I re-read Ernie's 14-page single-spaced lecture and was so impressed again with the achievements, and so proud of Ernie, that this "made my day." Ernie's career was influenced by Professor Schwarz at M.I.T. and Ernie used that occasion to outline some major achievements in the textile industry these last 45 years. Ernie's laboratory was involved in inventions to improve parachute line and cloth during World War II, improve combat clothing, flexible body armor, tire cord, heart valve fabrics, fire-resistant materials, water purification fibers, and, believe it or not, entrapment and frustration of amorous male insects to disrupt their sex lives and so prevent insect proliferation, and in turn, protect growing agricultural products against destruction by insects. Over the years Ernie personally contributed to many of these projects, but in his lecture he modestly placed greater emphasis and recognition on the hundreds of leaders in many corporations who were in the vanguard. His handling of the insect episode had just the right touch, and I could imagine how much it lightened the load on those who listened to his 14-pager. Ernie closed: "Finally, my dear wife shares in this honor. Without her and our children my activities in textile technology *might not* have been done and *would not* have been worth doing." Classmates can get a copy by writing Ernie at 67 Paulson Rd., Waban, MA 02168.

Other news comes from **Al Velho** who divides his time between international travels as vice-president for Sterling Drug Co. and recovering from those international travels when he comes home to his family at Scarsdale.

Henry Bagley has developed an efficient lightweight exterior wall system applicable to high-rise office and apartment buildings. . . . **George Rado** accepted appointment as professor in physics at Johns Hopkins University. . . . **Joe Neuendorffer** and **Fred Gemmill** both retired from business. . . . **Dick Cella** returned from a 12-day vacation near Naples, Italy to resume direction of his prestigious restaurant in New York.

Billie and **George Cremer** are away on another European junket and report from Bristol, England that the cathedral there listed only 0.01 inches since they were there the year before. I suppose their message had something to do with the stability of the English. George and Billie will be at reunion. . . . **Seymour Sheinkopf** is about to take some time off from the nuts and bolts of his Brookline hardware business to resume chairmanship of our 45th Reunion committee. When you all reply to his letters, please enclose newsbits which, in due course, will be relayed for inclusion in these notes.—**Hal Seykota**, Secretary, 1603 Calle de Primra, La Jolla, CA 92037

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On June 13, the American Nuclear Society (A.N.S.) presented its Walter H. Zinn award to **W. Kenneth Davis**, deputy secretary of the U.S. Department of Energy, at an awards luncheon in Detroit, where the society was holding its 29th annual meeting. This award is given for outstanding contributions to the advancement of nuclear power. . . . A note received from the Alumni Office brings us the news that **Lawrence Bernbaum** died at his home in Newton, Mass., on June 7. No other information available. . . . **J. Halcombe Laning**, department head of the Digital Computer Dept. of the C.S. Draper Laboratory, Inc., was one of 49 engineers elected to membership in the National Academy of Engineering, along with five foreign associates. Election to the Academy is the highest professional distinction which can be conferred on an engineer. He was honored for his unique pioneering achievements in missile guidance and computer science: the "Q-Guidance System" for Thor and Polaris, and "George," the world's first algebraic compiler.

A news clipping indicates that **David M. Heskett**, chairman of the Montana-Dakota Utilities Co., has retired recently. . . . **Roy M. Tuttle** is still working, but writes that his wife, Freda, who attended many reunions with him, died quite suddenly in April 1982. . . . **Joseph T. Lebsch** retired this past June as vice-president emeritus for research and Alcoa Professor Emeritus of Metallurgy and Materials Engineering. He received his bachelor's, master's, and doctoral degrees from M.I.T. Prior to joining the Lehigh faculty, he was a captain in the Ordnance Department of the U.S. Army, assigned to the Springfield Armory, Springfield, Mass., for metallurgical research and development of small arms. He has received many awards, especially in the fields of metallurgy and materials science, including election as a Fellow of the American Society for Metals (A.S.M.) and as national president of the Society during 1973-74. He has been a consultant for a number of manufacturing facilities and has written numerous articles and papers for professional journals. He and his wife, Eleanor, currently live in Bethlehem, Penn., and are the parents of three sons: Karl, who lives in Oregon; Lawrence, in Florida; and Thomas, in Michigan.

News clippings from the Hartford and Bristol, Conn., newspapers report the death of **William E. Hammond** in April. He received his master's degree in Marine Engineering from M.I.T. During World War II he was chief of the Scientific Section of the U.S. Maritime Commission in Washington, D.C. In 1947 he joined Air Preheater Company in Wellsville, N.Y., where he held positions as chief engineer, vice-president—engineering, and senior vice-president. In 1968 he was transferred to the Hartford area to take the position of director of international activities for the Industrial Group of Combustion Engineering—Windsor, where he remained until his retirement in 1974. He was elected a Fellow of the American Society of Mechanical Engineers and of the Institute of Mechanical Engineers in Great Britain. In addition, he held 22 patents in both Great Britain and the U.S. After retirement he was an engineering consultant on the international level. Bill is survived by his wife, Elizabeth, two sons, a daughter and four grandchildren.

William G. Peck writes from Fairfax, Va., where he is retired, that he is keeping busy with freelance writing and musical activities. Singing with the University of Maryland chorus, he will participate in the Salzburg Festival in July/August of this year. . . . A note from **William B. Singleton** in Baton Rouge, La., informs us that he is chairman of the Polish Refugee Committee of the St. James Episcopal Church, and co-chairman of the Interfaith Disaster Relief Committee of the Baton Rouge area. . . . **Len Weaver** sent an enjoyable letter to your secretary from his home in Walpole, Mass., where he reports that his retirement life of unscheduled activity is as active and as unscheduled as ever, including such matters as which grandchild is in the greatest need at any moment of an extra ration of the grandparent's time and largesse. He has had a great time ancester-hunting. Fortunately, several progenitors chose to settle in New England after escaping England during the days of Charles I. Unfortunately, no bank robbers or pirates seem to have been among them, to add a little spice to the research. He is still maintaining contact with the Neponset Choral Society, offering a word of advice when solicited.

I look forward to receiving news about your activities and I know that you enjoying hearing what is happening to your former class mates. Please keep it coming!—**Donald R. Erb**, Secretary, 10 Sherbrooke Dr., Dover, MA 02030, (617) 785-0540

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Joseph H. Myers retired July 1 as chief executive officer and chairman of The Stanley Works, after 20 years with that famous tool company. After graduating from M.I.T., he received an M.A. degree in business administration from the University of Chicago. He is currently president of the New Britain Institute, which encompasses a library, the Museum of American Art, and the Youth Museum. Joe was awarded an honorary Doctor of Humane Letters degree from Muskingum College, at New Concord, Ohio. Happy retirement, Joe.

Your secretary received a long letter from **Victor Forzley**, vice-president of Stone and Webster, who has just returned fom Riyadh, where he was assigned to the Saudi Central Bank. All classmates wishing information on Saudi Arabia, feel free to telephone our Arabic scholar Vic, at (203) 637-0117. And should you be near Cotuit, call (617) 428-2534; the Cape is as pleasant as the desert.

David S. Saxon was elected a new member of the American Academy of Arts and Sciences. . . . **Kenneth A. Roe** has just established the Kenneth Andrew Roe award to encourage Engineering Unity, in collaboration with the American Association of Engineering Societies (AAES), which Ken helped get started. The Columbia University Engineering School Alumni Association presented Ken with the Pupin medal for service to the nation in engineering, science, and technology. He is chairman of the board and president of Burns and Roe, Inc.

Martin L. Ernst, vice-president of Arthur D. Little, an expert on information systems, addressed the American Bar Association in March. Referring to the perpetual battle of locksmiths and the thieves, he described several ways that bank computers could be used to help the authorities detect failures to comply with income reporting laws. Gesundheit, Martin.

Lyle Richardson died in December 1982, in Conway, N.H., after a long illness. He was a senior vice-president of Horton, Church and Goff advertizing agency in Providence.

W. Keelor died in August 1981. . . . **James E. Gordon** died May 14, 1982. Your secretary remembers Jim Gordon very well; as a student Jim's many merry pranks were a delight during our M.I.T. days. . . . **Raymond F. Koch**, many years a neighbor at 285 White Oak Lane, Winnetka, Ill., died November 3, 1982.—**Joseph E. Dietzgen**, Secretary, Box 790, Cotuit, MA 02635

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We are certainly in the summer doldrums as far as news is concerned. However, a few really good items. **Maury Katz**, president of Jecon Metals Corp. in West Springfield, Mass., received an honorary degree of Doctor of Humane Letters from Western New England College last April. In presenting the honorary degree the college's president, Beverly Miller, said that Maury has "initiated activities which have enriched the lives of Western Massachusetts citizens." Our congratulations.

One retirement reported, that of **Steve Dodd** who has been with the Lincoln Division for 40 years. He must have been there when they started up the place! We wish him the very best of health and happiness in his new retirement career.—**Ken Rosett**, Secretary, 191 Albermarle Rd., White Plains, NY 10605

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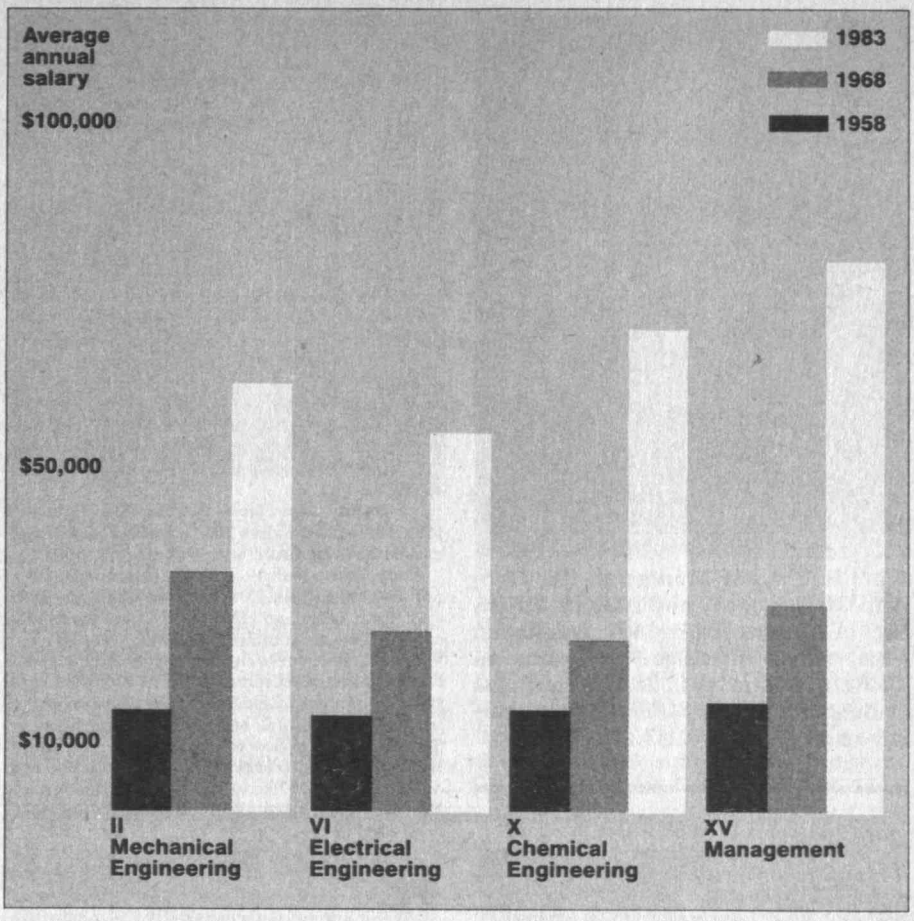
This month I have an embarrassment of riches. In addition to the 40th Reunion news, there are numerous letters, cards, clippings, and notices. Because of the volume of reunion information, I'll give you just the statistics this month, and the gossip later.



For the third time, James O. McDonough, '43, polled his classmates last spring in anticipation of a major reunion—same questions as in 1958 and 1968. From 452 questionnaires mailed there were 192 responses ("the classmates like this sort of nonsense," says statistican McDonough); 73 said they were in small business, 66 in big business, 3 in universities, 4 in government, and 7 had other employers. Salaries in small business averaged $61,000, those in big business $72,000. Just under 100 are still working in the fields in which they majored at M.I.T. (average salary $61,000); 84 have switched to different fields (average salary $59,000). The chart shows salaries reported on McDonough's three surveys by majors in four departments—the only fields in which there were enough respondents to provide a broad database. On McDonough's first questionnaire, 156 thought M.I.T. "the best"; only 118 now think so. In 1958 25 rated M.I.T. "good"; 53 did so in 1983. Two alumni rated it "miserable" in 1958, none in 1983.

First, **Stan Proctor** tells me that we produced the largest 40th Reunion gift in M.I.T. history: $2,288,455, of which $547,078 was earmarked for the Class of 1943 Career Development Professorship. We can be humbly proud. From **Kemp Maples** I learn that 95 classmates and 78 wives were registered for various parts of the Reunion weekend, with 159 showing up at the Cape Codder Hotel. Class officers elected for the next five years are: president, **Ken Warden**; vice-president, **Kemp Maples**; Eastern vice-president, **Mort Spears**; Western vice-president, **Chris Matthew**; secretary, **Bob Rorschach**; treasurer, **Hans Walz**; agent, **Jim McDonough**; estate secretary, **Stan Proctor**.

Now for the personal news. From Bath, Me., comes word that after 37 years with Bath Iron Works, **Richard R. Raven** has retired as vice-president of engineering. Dick joined BIW as a full-time draftsman in 1946, and during his career also served as drafting superintendent, assistant technical manager, and technical manager. He and his wife Patricia have three daughters. The couple will continue to make their home in Bath.

Henry R. "Bob" Brown says that he is now living in the excellent sailing port of Newport Beach, Calif. His activities include wind-surfing, folk-dancing, and backpacking. He is also building a solar home and marketing several inventions. I'll bet he's tanned and smiles a lot. . . . The *Wall Street Journal* reports that **Bob Gunther** has been elected a director of United Illuminating Co., New Haven, Conn. Bob is also chairman and president of George Schmitt and Co. . . . Retiring dean of the M.I.T. Graduate School **Ken Wadleigh** has re-

From left: Adolf Monosson, '48, Denman McNear, '48, and Martin Billett, '48, celebrating their 35th reunion in June, gather in Kresge Auditorium on Technology Day. A Lobdell Award was presented to Marty Billett during reunion activities. **(*See p. A3.*)**

ceived the Gordon Y. Billard Award, honoring special service of outstanding merit to the Institute. Ken remains on the faculty as a professor of mechanical engineering.

At the reunion I twisted the arm of **Sherman Sackheim** until he promised a letter, which I have now duly received. First, Sherm commented on what a fine group of dinstinguished (old, that is) classmates showed up for the 40th, and hoped that he would see them all again at the 50th. He asked to be excused, however, from wearing one of "those tacky red coats." Sherman lives in Clearwater, Fla., where he is a full-time realtor and part-time author. He is currently working on his first book, an action-packed account of real estate listing and sales. For those who noticed that Sherman was alone at the reunion, it was because, sadly, his wife Paula passed away last November. He does have three grown children, however, to recall 27 years of marriage. Thanks for the letter, Sherm.

We have two more of the sad, succinct notices. **Forrest S. Pearson**, Pearson Construction Co., Benton Harbor, Mich., passed away in 1981. . . . **Gilbert S. Graves III**, of Evansville, Ind., died in 1982. I'm sorry there is no more to report about these classmates.

The 40th Reunion was a great weekend, and I was glad to see so many of you there.—**Bob Rorschach**, Secretary, 2544 S. Norfolk, Tulsa, OK 74114

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Don Arsem corrects the recent report in the class notes to say that he retired as C.E.O. of Wurlitzer in 1978 and is currently chairman. Don, who is co-director, International Executive Program in Management and English Language, has been teaching fulll-time for the past five years in the School of Management, State University of New York at Buffalo, while his wife Kay produces a weekly TV program on key issues and teaches boardmanship to non-profit organizations. . . . **Robert P. Dodds** writes that he and Nan "finally sold the old homestead of 24 years in Rancho Santa Fe, Calif., and are in the process of moving to a condominium. All three children and grandchildren are close by in the area. My distributorship is 'on hold' during this recession, so I guess I'm retired and enjoying it by going to more free-flight model airplane contests. Am trying for the U.S.A. Wakefield team in free-flight for 1985 if I'm not too old, or fall off my motorbike while chasing my model." . . . **Trigg Noyes** reports that he "started 31st year with IBM Engineering in January. One of our two married daughters finally made us grandparents. Chartered and sailed Virgin Islands again in '82. Going for Strait of Georgia in British Columbia in '83." . . . **Jacquelyn M. Findlay** was honored for her 16 years in Corporate Relations, and Professor **H. Philip Whitaker** was honored for his 36 years in the department of Aeronautics and Astronautics at the annual M.I.T. Retirement dinner held in May.

Condolences to the families of **Bruce T. Benepe**, the chairman of Leacock & Co., a Manhattan manufacturer of linens and other household textiles, who died April 3; **Donald A. Tucker**, M.D. who died April 25 and who had been a physician to Harvard University Health Service since 1956; and **Emil de Agazio, Jr.**, a retired research staff member at the Laboratory for Nuclear Science at M.I.T., who died June 12.

I saw **Andy Corry**, **Jackie Findlay**, **R.J. Horn** and **John Taft** at Technology Day activities. Somehow I missed **Paul Heilman**, who was also registered.

Andy Corry, Barbara and **Bob Cummings**, Jane and **Lou Demarkles**, Dot and **John Gardiner**, Ruth and **Norm Sebell**, and Doris and **Chet Woodworth** spent a glorious summer weekend at Martha's Vineyard. The Sebells entertained aboard their boat docked in the harbor and talked of 40th Reunion plans. Norm would like you to volunteer to entertain classmates in your area; the upcoming holidays provide a good excuse to talk of Cambridge and Newport. Please contact me for a short list and any details you would like.—**Melissa Teixeira**, Secretary, 92 Webster Park, West Newton, MA 02165, (617) 332-7199

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I never cease to be amazed at the character and quality of some of our extra-curricular lives. Take for instance **Bill Brace**, recently made chairman of the new Earth, Atmospheric, and Planetary Sciences Department at M.I.T. When not involved in his department head duties (an honor all of its own), Bill is an athlete of some renown. A piece in the *Tech Talk* publication, complete with a picture of Bill running up Pike's Peak (looked at it in awe on my way to work in the morning), tells of the possibility of his appearing on Wheaties boxes as an outstanding amateur athlete. This as a result of excelling in crew racing, running, and mountaineering. Would you believe Bill has run in 30 marathons since 1972, along with two 50-milers? He was New England Marathon champion in his (our) age group in 1976-77 and was runner-up in the Pike's Peak Marathon. (How many miles and how many feet elevation gain is that, Bill?) In rowing he has placed second in lightweight doubles. Now there's a guy who did something with his V-12 training! (Or maybe inspite of it?)

I received the notes on Bill Brace via **Jim Goldstein**, who was thoughtful enough also to send congratulations to Bill. Jim was at M.I.T. in May to see his youngest son, Raymond, graduate with double degrees in physics and chemistry! How sweet those realized expectations!

Meanwhile, back into the 25th reunion booklet, I just wanted to say "hi!" to some fellows I missed seeing at the 35th: **Jim Corbett** V-12 roomie, was last seen working for Grumman on Long Island. . . . **Dick and Monroe Gleidman** still live in Scarsdale, N.Y. Both of them are orthodontists in New Rochelle. . . . **Sigurdur Halldorsson**, whom I can still see tripping the light fantastic with his wife, Sigrun, after coming all the way from Reykjavik, Iceland.

Ralph Huschke, a physical scientist with the Rand Corp., living in Rolling Hills Estates, Calif. . . . **Mason Lappin**, who has his own corporation involved in mechanical contracting in Malden, Ma., where he also lives. . . . **Bob Michaud**, vice-president with the Keymatch Computer Corp. in Needham, Ma., living in Bedord. . . . **Ed Richardson**, chief engineer with William Underwood in Watertown, Mass.

And did I tell you about our 25th wedding anniversary trip back to New Jersey in Bettie's "souped-up Colt and a ten-dollar bill?" Living it up in Motel Six's and pumping our own gas. Talk about cheap. . . . *Write Soon!*—**Jim Ray**, Secretary, 2520 S. Ivanhoe Pl., Denver, CO 80222

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Attending at least some of the Technology Day events were **Dave Clapp**, **Hugh Flomenhoft**, **Marty Haas**, **Claude Brenner**, Kathy and **Don vanGreenby**, Ruth and **Bob Horowitz**, **Harl Aldrich**, and **Ginny Grammer**.

Claude Brenner, president of Commonwealth Energy Group, Ltd., an energy management and planning company, addressed the June meeting of the Stein Club of Boston at Endicott House. Subject: Where Did the Energy Crisis Go? Thanks is also due Claude, whose conversation while doing the Alumni Fund Telethon stimulated the following notes on cards. **Norm Holland** is moving from the State University of New York at Buffalo to become the Richard J. Milbauer Professor of English and Eminent Scholar at the University of Florida, Gainesville, 32611. His eminence says two guesses as to reasons for the move. . . . Rear Admiral **Robert Blount** retired from the U.S. Navy September 1, 1982 following a four-year tour as the commander, Operational Test and Evaluation Force. After 38 years in the service, he will continue to reside in Norfolk, Vir. while consulting in New York and Massachusetts.

Bill Crawford

Last May another honor came to **Bill Crawford**, vice-president and general manager of the Engine Projects Division of General Electric's Aircraft Engine Business Group. Bill was awarded an honorary fellowship by the American Helicopter Society and cited for his life-long contributions to the advancement of the helicopter industry. The honorary fellowship is awarded to society members whose work toward the interest of the AHS has constituted outstanding achievement. Bill joins honorary fellows Igor Sikorsky, Frank Piasecki, and other industry leaders.

I (**Ginny Grammer**) had an opportunity this summer to teach an introductory LOGO course at Northeastern University, primarily for people who will be working with LOGO in the classroom. The course will be repeated in the fall, and will, I hope, develop into a LOGO center for educators at Northeastern. Cheers.—**Virginia Grammer**, 62 Sullivan St., Charlestown, MA 02129

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Our usually full mailbag is bursting at the seams with news about classmates. I will hold the news about the success of our 35th Reunion and the election of class officers until next month.

Bob Welsh joined Ludlow Corp., Ludlow, Mass., in 1948 as an industrial engineer. The original business began in 1868 and concentrated on manufac-

turing yarns, twines, and threads. Over the years Bob received a number of promotions moving up to executive vice-president and to vice-chairman of the board. In 1955 Ludlow went through a major expansion, and by 1981 combined sales of $300 million were achieved in paper converting, flexible packaging, textiles, furniture, foam products, and floor coverings. After a three-year battle Tyco Laboratories, Inc. took over Ludlow Corp. in 1981. After Tyco decided that the textile operations were not part of their long-range plans, Bob and another employee acquired the textile division early this year. Ludlow Textiles Company, Inc. has 100 employees and sales of near $10 million. Bob says, "It's the same employees, the same machines, the same plant, the same products, and the same customers." Only the owners are different. Bob and his wife, Margaret, have lived in Wellesley for 22 years. They have two daughters, Carolyn (30) and Nancy (23) and one son, Robert Jr. (28). Bob is a trustee of the Newton-Wellesley Hospital.

Murray Goddard retired last year after 32 years with the Physics Division of Eastman Kodak Research Laboratories. . . . **Boni Martinez** has become president of Kapejo, Inc. selling Boni Fibers[R], a polyester that is a substitute for asbestos. . . . **Sidney Crook** is enjoying retirement on Lake Sunapee, N.H. He traveled to England and Scotland last year. . . . **Milton Pohl** is a vice-president of Merrill Lynch. His son Bill is with IBM. His son Charles graduated from Bowdoin College in June, and his daughter Elizabeth is married. Milton has his first grandchild.

Dan Fink opened his own consulting business. He left General Electric in August 1982 where he had been senior vice-president for corporate planning and development. Dan's clients are in the aerospace and electronics industries and the work is primarily in corporate and business strategy. Aside from vast amounts of travel, Dan is enjoying the career change and the difference between his previous and current organizational structures. . . . **Herb Marcus** assisted in a far-off sea rescue. Herb was monitoring a ham radio network at his home in Winchester, Mass. when he heard a distress call from a 44-foot sloop, *The Magic Dragon*, in the Gulf of Mexico. The sloop was in a tough storm with big seas. After the sloop was taken in tow, a Coast Guard helicopter lifted off the exhausted five-member crew. Herb has assisted two other vessels issuing distress calls. After using the telephone to establish communication, he has patched the distant vessels with the Coast Guard in their area.

Robert J. McDonagh was appointed chief engineer of the Massachusetts DPW. Bob has been with the department since 1950, and previous promotions include deputy chief engineer for project development and deputy chief engineer for highway engineering. Other major assignments include highway and structures engineer and bridge engineer. Bob is a registered professional engineer and has been active in professional organizations in Boston and nationally. He is a native of Boston and now lives in Hingham. During the 16 years he lived in Plympton, Bob was active in town government serving as a moderator, selectman, and finance committee member. At the time of Bob's recent appointment, the commissioner said that his new position was one of the most sensitive posts in the department, which has 2,800 employees, an operating budget of $85 million, and over $400 million in statewide construction projects underway.

Gil Rohleder was named as Mapco's executive vice-president of marketing, refining, and transportation in January 1983. . . . **George Brown** retired from American Motors in January 1983. . . . **Elton Hammond** is a member of the national board of directors for American Youth Hostels, Inc. He was elected secretary for 1982-83. He is a past president and currently active member of the Lima Council of AYH. He bicycles about 2,000 miles per year and hikes about 100 miles per year. Elton is treasurer of Christ Church Episcopal. He is employed as a senior design engineer with Westinghouse Electrical Systems Division. . . . **Fred Firestone** taught economics for 20 years. After that, he went to law school (Yale and Virginia) and was admitted to the bar. Fred is now teaching law at Oklahoma City University School of Law. He is doing some labor arbitration. . . . **Bill Shempp** has been named director of air cushion vehicles at Bell Aerospace Textron. Bill will be responsible for all program management functions at Bell's facilities in Western New York, Ontario, Canada, and Virginia.

Bob van Ravenswaay died in January 1983 from a cerebral hemorrhage. He was in the hospital recovering from an accident. Bob had been living in Swarthmore, Pa. He had worked for United Engineers and Constructors since 1948. His projects were primarily in steel mill construction. He also worked on the nuclear submarine program during the fifties. Bob's wife Janette died in 1969, and he remarried Julia Leedom in 1971. He had played flute in the Landsdowne Symphony since 1956 and contributed to the musical life of the community by playing the flute in several other groups. On behalf of our class, I extend our sympathy to his wife and other members of his family.

Four other classmates have died in the past few years. Our belated sympathy to their families. **Paul Barcus** died in December 1982. Paul was associated with Iowa State University. . . . **Clarence Jacobsen** died in December 1981. He had resided in Landing, N.J. . . . **Ernest Klipfel** died several years ago. He had been with Westinghouse in Pittsburgh, Pa. . . . **Robert Price** died in 1981. He had worked in Tacoma, Wash.—**Marty Billett**, Secretary, 16 Greenwood Ave., Barrington, RI 02806

"Open Horizons," a painting by Gyorgy Kepes professor of visual design emeritus, was commissioned by the Class of 1948 for its 35th reunion. It was sold at auction by the class, but posters reproducing it (above left) are available for $25 each at the M.I.T. Museum. Proceeds of the project, designed to celebrate Professor Kepes' unique contributions to the Institute, will be a class gift to the Alumni Fund. Above right: Professor and Mrs. Kepes (left) visit with the class after the auction conducted at the M.I.T. Museum.

49 35th Reunion

Jack and **Jerry Kunstadter** are not only rare for being husband-wife '49ers, but they now are the only husband-wife combination to serve on the board of the prestigious Menninger Foundation. . . . **Davis Baker Keniston** and his wife Priscilla moved to Vermont shortly after graduation and have stayed the course in that lovely state. They have four grown children. Dave is chief engineer of numerically controlled lathes for Jones and Lamson. He has been deeply involved over the years

Jerry and Jack Kunstadter

with the local planning and development commission. . . . **George Hatsopoulos** has recently spoken out against the higher cost of investment capital. He feels that we must have tax incentives or federal subsidies if we are to continue as a leader in high technology.

Some recent promotions show the advancement that our classmates are enjoying: **Joseph Yamron** to chairman of the board of Associated Industries of Massachusetts; **Dwight Hibbard** to president of Cincinnati Bell; **Angelo Arena** to president and CEO of Hutzler Bros. Co., Baltimore, Md.

Jack Baker sadly reports that his wife, Mary Ann, died last year. We remember Mary Ann well. She attended all our reunions with Jack except the 15th. Jack is still busy with Management Recruiters, as he has been for many years. . . . We also report the death of one of our graduate classmates, **Wilfred Chope**. Bill is well remembered by those who attended the Cape Cod reunion because he flew in his own plane and had his pilot take photographs of each person which he later sent to us.

The 1983 Alumni Day cocktail party had 19 classmates in attendance. New faces were **Dan** and **Charlotte Gassman**, **Fred Blatt**, (my old tennis-playing neighbor from Needham), and **Dick Amon**. These joined the **Lambes, Margolins, Hulswits, Schneiders, Christophers, Ligors, Eatons,** and **Mal**

Bigus: Money Still to Make in the Market

The U.S. economy has turned a corner, says **Anatol W. Bigus, '49**—slower long-term growth, greater social welfare commitments, reduced productivity that can only lead to reduced tax payments, increasing imports of strategic materials, growing ratios of debt to capital . . .

And with these changes, says Mr. Bigus, an independent management consultant, investors need new systems to select investments and time their buy and sell decisions. But Bigus is convinced that an investor pursuing a "conservative program based on analyzing fundamentals" can still preserve and add to his capital in the market.

The details of how are in Bigus' new book, *Make Yours in Stocks and Bonds at Little Risk* (Hampol Publishing Co., Box 36, Boston, MA., 02134, 1983, $17.50). In simplest outline, the evaluation is based on balance sheets and investment valuations calculated from historical price/earnings performance, company size, and past earnings fluctuations. Reviewers think the book "of interest to investors looking for solidly based theory."

Kurth. That last group is most of our 35th Reunion committee. And they announced—IT IS BERMUDA IN 1984. If my calculating is correct, Thursday, June 9, will start things going with our gigantic cocktail party and then to the Pops. Friday, we will do local things, and then Saturday, take off for the Inverurie in Bermuda with special pricing for four or seven day stays. More to come from our committee. Plan it. Y'all come, y'hear!—**Paul E. Weamer**, Secretary, 331 Ridge Meadow Dr., Chesterfield, MO 63017

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Lindsay Russell would like to remind you of the following: Wednesday, October 5, will be the date of the annual get together at M.I.T. of 1950ers and those students now being aided by our Class Gift Scholarship Fund. This dinner is becoming a mini-reunion of sorts—a chance to see classmates, a chance to meet some impressive young people (often kids of someone you know). Jot down the date if you're close enough to attend or, if you can, perhaps finagle a business trip this way in early October. There will be a detailed mailing to all soon.

The Corning Glass Works of New York announced a major reorganization on April 12, 1983. As part of the reorganization, **Thomas Howitt, Jr.**, was appointed vice president-purchasing and transportation. Tom has been with Corning since 1950 and has held many different positions in both the staff and operating divisions. . . . **Peter G. Dayton** is presently in the department of pharmacology at the Dartmouth Medical School. . . . After 15 continuous years in Europe and Singapore, **Roy Jenkins** moved back to Houston four years ago. As a worldwide troubleshooter in offshore marine construction, Roy spent parts of last year in England, Australia and India and, when we heard from him, was about to leave on a trip to Beijing, China. . . . **Edgardo J. Parsi** is presently vice president—research and development of Ionics, Inc., located in Watertown, Mass. . . . We are saddened to hear that **Tsuruzo Takeda** passed away on July 27, 1982. . . . Also, we regret to announce the death of **Robert J. Sullivan**, a manager of international purchasing for the Gillette Company in Boston, a position he had held for 12 years. Bob died of cancer in February. He traveled widely with Gillette, going to Brazil as a manager in 1959, and then to Australia in 1961. He moved to Sherborn in 1969. At the time of his death he had been with the firm 33 years. He leaves his wife, Barbara; two sons, Robert J. Jr. and Peter D., both of Sherborn; and a daughter, Marcia M. of New York.

Warren H. Smith, president of Smith Architectural Group, Inc., located in Lakeland, Fla., gives us the following rundown on his current work of interest in Florida: Zurn Industries, Inc., office headquarters building in Tampa; Florida Atlantic University, arena building in Boca Raton; Lakeland Shopping Mall in Lakeland; and Wines of St. Augustine in Tampa. . . . **Edward S. Cohen**, executive vice president of General Sekiyu, K.K., Tokyo, has been named treasurer of Esso Eastern, Inc., Houston. He will also be manager of Esso Eastern's Finance and Planning Department. Esso Eastern, Inc., is responsible for Exxon Corp.'s energy business in the Far East and Australia. General Sekiyu, K.K., which refines and markets petroleum products in Japan, is 49 percent owned by Esso Eastern, Inc. Ed began his career as a research chemist with Exxon Research and Engineering Co., Linden, N.J., in 1956. He transferred to Exxon Production Research Co. in 1960 and was assigned to Exxon Corp.'s Corporate Planning Department in 1964. He was named Esso Eastern's assistant treasurer and assistant Finance and Planning Department manager in 1968. In 1970 he was appointed a director of Esso Standard Thailand, Ltd., Bangkok, and in 1973 became Esso Thailand's managing director. He was appointed vice president of Esso Sekiyu, K.K., Tokyo, in 1976 and was appointed executive vice president of General Sekiyu in 1979. . . . **Frederick J. McGarry** has been appointed director of the Summer Session at M.I.T. Professor McGarry also will continue as a member of the faculty of the Department of Materials Science and Engineering, where he is professor of polymer engineering and civil engineering. He has been at M.I.T. since graduation in 1950. The Summer Session offers 50-60 one- and two-week intensive courses designed to inform persons from industry, government and other educational institutions about recent advances and current state of the art in areas such as science, engineering, management, economics, architecture and medicine.

Robert W. Mann, internationally recognized for his contributions to engineering design, engineering education and research oriented towards the rehabilitation of the blind and amputees, has been selected as the 1983-84 recipient of the James R. Killian, Jr., Faculty Achievement Award. The award recognizes extraordinary accomplishments by M.I.T. faculty members and was established in 1971 as a tribute to Mr. Killian, M.I.T.'s 10th president and former chairman of the Corporation. Dr. Mann has been issued several patents, authored over 200 publications, and has received many awards, including the United Cerebral Palsy Goldenson Award for outstanding technological research for the handicapped, the Gold Medal of the American Society of Mechanical Engineers, the New England Engineering Society Award and the Bronze Beaver Award of the M.I.T. Alumni Association. Receiving the Killian Faculty Achievement Award is not the only honor to come to Dr. Mann. He became the 88th president of the M.I.T. Alumni Association when he was inducted into that office at the Technology Luncheon on June 10. Dr. Mann lives in Lexington with his wife, Margaret, who has a Radcliffe A.B. in physics, was on the research staff at M.I.T. and has an advanced degree from Harvard Divinity School. Their son, Robert Jr., has two M.I.T. engineering degrees and their daughter, Catherine, a 1977 Harvard University graduate, is now a graduate student in economics at M.I.T. . . . **John F. McCarthy** was among the 115 people who have retired during the past year or planned to close their careers at M.I.T. at the end of June. Professor McCarthy served for 31 years as professor and director of the Center for Space Research (Aeronautics and Astronautics). . . . **Richard D. Lemmerman** is presently president of Terra-Light Corp., manufacturers of solar absorbers for commercial and residential solar heating systems. Dick and a group of Boston investors purchased Terra-Light from Butler Manufacturing Co. The company will continue its manufacturing and marketing operations at its present 70,000 square feet facility in Cherry Hill Park, Danvers, Mass. Terra-Light is the country's leading O.E.M. supplier of absorbers to solar collector manufacturers. . . . Since 1970, the controversial **James H. Kennedy** has been the successful editor and publisher of *Consultant News*, based in New Hampshire. After being fired by an international consulting organization in New York for leading a "place revolt" which, he says, failed, Jim set out on his own and reports that it is the best thing that has ever happened to him. . . . It is with sadness that we report the death of **Louis A. Russell**. Lou passed away February 20. He leaves his wife, Carolyn.—**John T. McKenna**, Secretary, 1 Emerson Pl., 11-H, Boston, MA 02114

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We regret to report the death of **John M. Downie** May 5 in an automobile accident. . . . **Joseph C. Murphy** writes that he is now out of the industry, but not retired. He is teaching engineering theory and applied engineering at Blue Ridge Technical College in Hendersonville, N.C. . . . **Allen F. Moore III** is enjoying his career in architectural graphics in California.—**Gregor J. Gentleman**, Secretary, 818 Southwest Ninth Street., Des Moines, IA 50309

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F. Alexander Magoun, who was secretary of the Class of 1918 for many years, prided himself on finding a profound theme that tied the items in each of his columns into a graceful whole. I should like to do as well, but this month's collection of news, while all very interesting, has me stymied. Alphabetical order seemed to provide the best unifying structure. Judge for yourself.

Joseph F. Alibrandi, president of Whittaker Corp., was made an honorary Doctor of Science in Business Administration last May by Bryant College, Smithfield, R.I. He was also speaker at the graduate school commencement. . . . A letter from **Henrik Bull** informs us that his architectural firm, Bull Volkmann Stockwell, of San Francisco, won a competition for a master plan for a 165-acre site in San Jose to be developed by Syntex Corp. to provide for their future growth. . . . Another architect, **Matthew Goodwin**, in addition to practicing architecture, has written a two-volume book, *Numerology: The Complete Guide*. . . . Another Goodwin, **Samuel Goodwin**, who teaches science at East High School in Rochester, N.Y., provides amusement for himself and pleasure for others playing string bass with the Upstate String Band, and bass and cello with several other groups.

Whether for his work or service, I don't know, but **Robert King** last year was given the Distinguished Salesman Award by the Sales and Marketing Executive Club of Durham, N.C. . . . **Glyndon Lynde**, in contrast, has rewarded himself, by retiring to "beautiful Carmel Valley." Trust a meteorologist to pick a spot where the weather scarcely varies.

With appropriate efficiency for an engineering school, Stevens Institute of Technology has managed to honor both **Gerald Rothberg** and George Meade Bond, a Stevens alumnus, by appointing Dr. Rothberg as the first George Meade Bond Professor of Materials and Metallurgical Engineering. He is also head of the Department of Materials

and Metallurgical Engineering, and professor of physics, among other things. However, in the same spirit of efficiency, he is only paid one salary.—**Richard F. Lacey**, Secretary, 2340 Cowper St., Palo Alto, CA 94301

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Although you're reading our class notes in October, this is the first chance to let you know about our 30th Reunion in June. Between the festivities on Martha's Vineyard and those in Cambridge, 30 of our classmates along with spouses, family, and friends participated. Of course, everyone had a great time, as a result of the hard work of our reunion co-chairmen, **Dave Berg** and **Richard (Dick) Lindstrom**. I understand from them that ours was a rather large turnout for a 30th. We gathered from all over—Hawaii, California (three), Florida (to name a few distant states), and even some from Massachusetts. I hope that many more will be able to join us in 1988.

Those who paid class dues have received their copy of the survey response to all the questions, answered by exactly 100 of us. For everyone else, I'll provide a few results of interest from time to time.

Class elections took place at our banquet in Cambridge. **Fred Brecher** and **Dave Berg** were re-elected president and vice-president, respectively. **Gil Gardner** "reluctantly" relinquished his job as class secretary and was elected class agent, replacing **Maurice (Mo) Gionfriddo**, who has ably served in that position for 15 years. Many thanks for your work on behalf of our class.

Wolf (Bill) Haberman and **Joseph Cahn** were elected co-secretaries, with Joe, who is an attorney in Los Angeles, responsible for providing information on happenings on the West Coast. We will try to provide you with some information on classmates every month. Some of your "old" friends from Tech would like to know what you're doing just as you are reading this to find out whatever happened to so-and-so.

Many of you have written in about where you are and what you're doing, and I'll try to cover as many as I can in this issue. **Frederick E. Jellow** is working in California as a contract engineer apparently at Vandenberg AFB. . . . **Albert C. Lee** writes that he's with General Electric working in the power systems area. . . . **John R. O'Donnell** is a manufacturer's representative in the steel industry, but John didn't say which company (maybe its all of them).

At least one of us has retired. **Ray C. Burrus, Jr.** left General Motors in 1980 and is now a full-time student at Florida Atlantic University working towards an applied science degree this year. Most of the rest of us are still working away, though.

Clifford E. McLain writes that he's now vice-president for corporate development of the SPC Group and president of the subsidiary, SPC Venture Corp., which is dedicated to R&D ventures. . . . **Morton Grosser** is just writing. He's almost finished a new adult novel set in 1921. Perhaps when it gets published he'll let us know the title. Mort is doing some consulting and is a Bohemian Club member. . . . **Stephan A. Kliment**, an architect and consultant, is a senior editor at the Whitney Library of Design. He also taught portions of a course at Tech this past summer. . . . A news release from Gilbane Building Co. in Providence, R.I. informs us that **Robert P. McDonald**, having joined them in 1980, is now a senior vice-president there and the manager of the Northeast Regional Office. . . . From the *Hingham* (Mass.) *Journal*, we learn that **Alexander H. Danzberger** was elected second vice-president of the American Society of Chemical Engineers of which he is a fellow. Al is obviously one of the 70 percent of our class who is still in the same field in which he received his degree, based on the survey. He's an "executive" with Domes and Moore in Denver, Colo.

Sidney W. Hess, who was with us at the reunion, is a vice-president of ICI Americas, Inc., in Wilmington, Del. and is the recipient of the 1983 Memorial Award presented by the Chemical Research Association. Sid and his wife Grayce have three children and live in suburban Wilmington. Sid is a member of and active in a number of professional organizations and served on President Carter's Advisory Panel for Domestic Policy Review and Innovation. . . . another news release from the MITRE Corp. informs us that **Gerard P. Langelier**, who lives in Quincy, Mass., was promoted to technical director, responsible for work on the E-3A AWACs and foreign military work. We have several other classmates at MITRE, including **William S. Gouse**, **Ernest P. Runnells**, and yours truly.

Along with all this good news, we received some sad news about some of our classmates who are no longer with us. Among them are **Robert P. Bunikis**, **Vincent C. Gilbert**, **Alice (Schomburg) Maher**, **Robert F. Packard**, and **Bennett Sack**. Our sympathies to their families. They will all be missed. Alice's mother informs us that both Alice's father and daughter also received M.I.T. degrees.

To end on a high note, since we intend to have class notes in every issue of *Technology Review*, please send us some material, either directly or through the Alumni Office. Hope to hear from you all soon. Co-secretaries: **Wolf Haberman**, 41 Crestwood Dr., Framingham, MA 01701; **Joseph M. Cahn**, 289 Bronwood Ave., Los Angeles, CA 90049

54 30th Reunion

Bob "Gramps" Warshawer (his grandaughter Rachael Ostrow is approaching her first birthday) has advised that all is proceeding well for our 30th Reunion June 7-10, 1984. Further details will be forthcoming when final arrangements have been completed. His wife Natalie recently displayed her works at an art exhibition. Included was a very fine hand-colored etching of the Massachusetts State House, which was designed by Charles Bullfinch.

Dave Dennen has been named vice-president of the biochemicals division of Eli Lilly and Co. . . . We recently received the following from **Hugo Belalcazar**: "After many years of work in economics and finance, primarily as a consultant, I have recently returned . . . to the field of my original training at M.I.T., as president of Alcalis de Colombia Ltd., a company which produces salt and salt derived products. Talking about chemical and electrochemical processes has brought me back to my first years at M.I.T." After graduating from M.I.T. in chemical engineering, Hugo stayed on to get an M.S. in management. In 1969 he received an M.B.A. from Harvard.

On a closing note, we are sorry to report that **Alan Block** died on April 15, 1983. We extend our condolences to Mrs. Block and her children, who live at 4331 Geislen Center, Birmingham, MI 48010.—Secretaries: **William Combs**, 120 West Newton St., Boston, MA 02118; **John Kiley**, 7 Kensington Rd., Woburn, MA 01801; **Louis Mahoney**, 52 Symor Dr., Convent Station, NJ 07961; **Dominick A. Sama**, 28 Chestnut Hill Rd., Groton, MA 01450

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Hello out there! We are blessed this month with a number of hard news items which we duly report. **Charles C. Ladd**, professor of civil engineering at the Institute, was elected to membership in the National Academy of Engineering for his work in developing unifying principles governing clay behavior and innovative design procedures related to soft ground construction. . . . Not to be outdone, **Norman F. Ness** was elected to membership in the National Academy of Sciences. Norm is the chief of the laboratory for extraterrestrial physics at the Goddard Space Flight Center of NASA in Greenbelt, Md. . . . **Russell G. Meyerand**, vice-president, technology, for United Technologies, Inc., presented a check to President Paul Gray for the first installment of his company's $250,000 per year, three-year contribution to the microsystems program of M.I.T.'s Department of Electrical Engineering and Computer Science. . . . In addition, **R. Winslow White**, president of NL Treating Chemicals, a division of NL Industries, Inc., of Houston, Tex., presented a $15,000 check establishing the NL Industries Foundation Scholarships for $2,500 awards to each of three M.I.T. students for their accomplishments in their junior and senior years in the fields of electrical engineering, computer science, mechanical engineering, or metallurgy.

Turning to individual achievements, **Richard T. DiBona** was elected chairman of M/A-Com (formerly known as Microwave Associates). In addition to his new hat, Dick will continue to serve as president and CEO of the company. . . . **Keatinge Keays** of Arlington, Mass. retired from the M.I.T.'s ocean engineering department after 15 years service.. . . **Ely S. Lurin**, who manages both corporate development and market research at Western Union, reports that he completed the nine-week program at M.I.T. for senior executives at the Sloan School last spring. Ely lives in Great Neck, N.Y. with his wife and two children.

For those of you who are in need of a new boat, please be advised that **Seabury C. McGown** has been elected vice-president for contracts, Uniflite, Inc., fiberglass boat manufacturer of Bellingham, Wash. and Swansboro, N.C. He is responsible for governmental marketing, bidding, and contract administration as well as other commercial boat business. Seabury joined Uniflite in 1967 as chief engineer after 11 years as a civilian engineer at the BuShips in Washington, D.C. He resides with his wife Frances and family in Bellingham, Wash., where he is an active racing sailor. . . . Last spring, **Charles Pickering** ran for selectman in West Bridgewater, Mass. Besides operating his own company in West Bridgewater, he has been very active in community activities, serving as town engineer in 1963-64, as town engineering consultant from 1965 to 1968, and having served on the Zoning Study Committee and the Bicentennial Committee in past years. How did the election go?

In a short note accompanying a contribution to the Alumni Fund, **George B. Raymond, Jr.** advises us that he is currently working in the production planning department of Renault at their headquarters outside Paris. . . . We have also learned from a news clipping that **John A. Welsh**, director for entrepreneurship at the Caruth Institute of Southern Methodist University in Dallas, spoke at an awards dinner in Dartmouth, Mass. last spring. John is the founder and chief executive of Flow Laboratories, the treasurer of Thermo Electron Inc. of Waltham, Mass., and the president of Joseph Kaye Co. In his spare time he has managed to co-author *The Entrepreneur's Master Planning Guide* and *Administering the Closely Held Company*; and the television series, *That's Business*; as well as an article recently published in the *Harvard Business Review*.

Finally, we are saddened to conclude with the report that Commander **Jesse R. Watt**, director of the Torpedo Division of the Bureau of Naval Weapons, U.S. navy, died last year.—Co-secretaries: **Marc S. Gross**, Winding Road Farm, Ardsley, NY 10502; **Allan C. Schell**, 19 Wedgemere Ave., Winchester, MA 01890

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Charles A. Berg has been appointed chairman of Northeastern University's department of mechanical engineering. Prior to his appointment, he was a private consultant and inventor. He has received more than a dozen patents for radiant heat recuperators and solar-powered heat pumps—devices used to control heat in high-temperature metal-shaping operations. He has published extensively in the areas of thermodynamics, energy conservation, and technology assessment and analysis, and has written a soon-to-be-published book on the nature of innovation. Berg's career spans academic and government service. He has taught at the University of Houston, at the University of Pittsburgh (where he was chairman of the mechanical engineering department), and at M.I.T. (where he supervised and developed a graduate

program in solid mechanics and built a composite materials laboratory). His government positions have included chief engineer for the Federal Power Commission and deputy director for engineering at the National Bureau of Standards. After obtaining his bachelor's degree with our class, Berg stayed at the Institute for graduate studies, obtaining an M.S. and Sc.D. in Mechanical Engineering. Currently, he and his wife, Judith, divide their time between Boston and a hand-made wooden home in Buckfield, Maine. . . . **Daniel J. Wolfson** left his position as first vice president of the Tishman Construction Corp. to become senior vice president of the Georges A. Fuller Co. In his new position, Wolfson will assume a major role in the operations and business development of the 101-year-old firm, both on the local and national levels. He will also be responsible for directing all facets of the company's construction activities involving high rise office buildings, multi-story apartments, hospitals, libraries, hotels, research centers and suburban office parks. He resides in Stamford, Conn., with his wife, Sheila, and two children, Arin and Shari.

At its annual meeting held at the Rhode Island Country Club, the Chemical Club of New England announced that **Ed Najjar** had been appointed as director of the organization. Ed is vice president of research and development with the W.R. Grace Corp. in Lexington, Mass. He lives in Lincoln, Mass., with his wife, Gail, and their three children, Michael, Susan, and Elizabeth. . . . A short note from **G. Gordon Sammis** informs us that "After 25 years designing ships and boats, I now find myself in an airplane factory! Now completing sixth year at Grumman and kids completing college. Should have been a dentist! . . . **Carl Alexoff** was recently named President of Webcraft Games, Inc., a subsidiary of the Beatrice Foods Co. He holds three patents on the design, construction and manufacture of computer-based instant lottery tickets and systems. He recently gave a paper on this subject at the XIV Congres de l'A.I.L.E. in Lausanne, Switzerland.

The fact that we are an aging class was partially confirmed by the notices of retirement from two Graduate School members of the class. **William J. Jones** retired from the Energy Laboratory after 25 years of service at M.I.T. . . . **David J. Goldstein** informs us that he has retired from other business, and is teaching in the Chemical Engineering Department at M.I.T. on a part-time basis.

A non-reversible and sadder indicator of the temporal position of our cohorts is the death of three of our classmates. **Robert S. Welther** passed away on August 15, 1982. His last known address was Westchester, Calif. No other details are available. . . . **Richard A. Alden** passed away in La Jolla, Calif., on April 28, 1983. He was on the staff of the Chemistry Department at the University of California, San Diego. He is survived by his wife, Sally, and their three sons, David, Jeremy and Jonathan, to whom we offer our condolences. . . . **John S. Saloma III** died on July 6th, 1983 at the Kaiser Foundation Hospital in San Francisco of cancer-related complications. Jack was a nationally recognized authority on the American political system. While we knew him as class president early in his career, he will be best remembered as one of the founders of the Ripon Society, a moderate Republican research and policy organization, and for his pioneering studies in congressional reform and political party organizations. In 1969, he published "Congress and the New Politics," a study of congressional staffing and performance. He collaborated with Frederick H. Sontag on a study of political parties for the 20th Century Fund, which resulted in the book, "Parties: The Real Opportunity for Effective Citizen Politics," published in 1972. Shortly before his death, he completed the manuscript of a major study on the conservative movement. A book based on the study, "The New Political Order: A History of the Conservative Infrastructure," will be published in the fall. He held a master's degree and a doctorate in political economy and government from Harvard University, and was also a Fulbright Scholar at the London School for Economics. John was a staff associate of the John F. Kennedy Institute of Politics at Harvard, and had been a Congressional Fellow of the American Political Science Association with former Senator Leverett Saltonstall of Massachusetts and Representative Thomas Curtis of Missouri. He was research director in the first senatorial campaign of Edward W. Brooke of Massachusetts in 1966. In 1969, he was elected as one of "Ten Outstanding Young Men" by the U.S. Junior Chamber of Commerce. He taught political science at M.I.T., Harvard, the University of Massachusetts in Boston, San Francisco State University, and most recently, St. Mary's College in Moraga, Calif. While continuing to pursue his interests in political science, Jack became involved in analysis of the consciousness movement and moved to San Francisco in 1974 to pursue that interest. He was a board member of Berkeley's Institute for Study of Consciousness. He leaves his mother, Mrs. Impi Koski Saloma of Weymouth, and a sister, Joan S. Menice of South Weymouth, to whom we send our condolences.

Jack was sufficiently well known for his death to have been noted by most of the major newspapers in the U.S., which prompted the following letter from **Bob Alter**: "I was rather shocked by today's *Chicago Tribune* obituary column. Jack Saloma was a friend of mine and a distinguished member of our class. I thought perhaps that some sort of memorial fund might spontaneously surface. Please find enclosed a contribution to the M.I.T. Alumni Fund in Jack's memory. . . . As I have started this letter, I suppose I must add some history. Our son Jay will be a freshman at Stanford this fall; our son Michael will be a junior at Highland Park, Ill., High School, and our daughter, Alison, will enter seventh grade at the Junior High. My wife Barbara has provided me with much needed support and encouragement for the past two and one half years as I have battled with lymph cancer. I hopefully may be ahead." I called Bob to thank him for his contribution, and to wish him as speedy a recovery as possible. . . . Shortly after Jack's death, I had occasion to speak to **Bill Grinker**, who also suggested that a memorial fund be established in Jack's memory.

In the past month's mail, there was also a check to the M.I.T. Alumni Fund from **J.W. Katz** of St. Paul, Minn., in memory of **Richard I. Teper** who passed away in Los Angeles on May 12, 1983, as reported in the last issue of these Class Notes.

Mightn't the above seeds be the initial contributions to a Memorial Fund in honor of the above and the other deceased members of the Class of 1956? We would appreciate hearing the views of other members of the Class of 1956 on this matter.—Co-secretaries: **Robert Kaiser**, 12 Glengarry, Winchester, MA 01890, (617) 729-5345; **Caroline Disario Chihoski**, 2116 W. Davies Ave., Littleton, CO 80120, (303) 794-5818

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The National Academy of Sciences announced the election of 60 new members, one of which is **Alar Toomre**, professor of applied mathematics at M.I.T. . . . **Martha Norman** writes that her daughter, Cyndi, completed her freshman year at M.I.T. last June. . .. Ruth Ellen and **George Beerli** sent along a brief note from Mobile, Ala., the Azalea City. George has had a busy spring putting together the Toastmasters' convention for the Gulfcoast Region, and it was a great success. . . . **Stanley Kroder** is with the IBM Corporate Information Systems Education Department in Irving, Tex. His oldest daughter graduated from Muskingham College, Ohio. His son graduated from high school and is heading to Texas Christian University on a swimming scholarship.

Dennis Begany is market research manager for CE-Lummis, a subsidiary of Combustion Engineering. He is involved in market research, business analysis, and strategic planning. As of this September, two of Dennis' four teenagers will be in college. . . . **Robert Kyser** recently started his own management consulting firm in Newport Beach, Calif., named appropriately, R.C. Kyser and Assoc., Inc. The firm specializes in cost reduction and productivity improvement. . . . Norma and **Detlev Hasselmann** visited the East Coat in June when they attended Norma's 25th anniversary at Wellesley and showed daughter Heather the East Coast sights. . . . Detlev wrote that he is still hoping to chuck it all and sail around the world for a couple of years.

According to the March 25, 1983 edition of the *Vineyard Gazette*, **David Wright**, whose company (Wright and Wright, Inc.) is located on Martha's Vineyard, has gained the attention of oil companies around the world with the development of an electronic monitor that uses infrared light to detect dangerous hydrocarbons in oil refineries, tankers, and pumping stations. . . . I recently received news that **Harold Miller** was elected vice-president of ITT Corp. in August 1982. In addition to his election as corporate vice-president, Harold has also been named group executive of ITT Telecommunications, North America. Ethel and Harold are now living in Raleigh, N.C.—**Vivian Warren**, Secretary, 156 Northrop Rd., Woodbridge, CT 06525

59 25th Reunion

This past summer I heard from our regular class secretary, **Larry Laben**, who was visiting the U.S. to attend his daughter's college graduation from Smith. Larry called just before returning to Japan. . . . **Sheldon Razin** advises that his company, Quality Systems, Inc., just went public. The company creates turnkey minicomputer systems for the health care industry. . . . **William Burke** writes that he opened South Star Computer Co. in April in Baton Rouge, La. He is looking forward to the 1984 reunion.. . . A recent announcement notifies us that **W. Scott Latimer** became vice-president for ASARCO. Scott has been with ASARCO since 1966.

Dit Morse, who is with Frey Federal Systems in Merrimac, N.H., is the messenger of the sad news of the death of his fraternity brother, **Charles George**, in an automobile accident in March 1983. Charles was a member of President Reagan's Private Sector Survey Task Force for Federal Construction and president of G2S Constructors in Meredith, N.H.. . . We have also just learned of the passing of **Miguel Colina Marie** of Brookline, Mass. who died in August 1982.—**George L. Barnett**, Acting Secretary, 90 Broad St., New York, NY 10004

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My excuse for missing last months notes is a change of jobs. I spent most of June moving my lab from Harvard to M.I.T. It took several weeks and things are still a bit confused in the middle of July. I'm now in Building 20 (that wooden temporary World War II structure you all thought would burn down by 1962), and you all are welcome to visit when you come back to check the old place out. There are a couple of undergraduate students in the lab just now and I can report they are far smarter than I am. By the end of the summer I expect they will be telling me what to do. In any event I am proud to be back and look forward to many fruitful years back at M.I.T.

Pete Buttner writes that his son Karl was accepted by lots of universities (including a well known Ivy League school down Mass. Ave.) but has opted for M.I.T. Daughter Lisa, a high school junior this year, is also a prime M.I.T. prospect. . . . Class President **Bennet Zarren** was written up in the *Woburn* (Mass.) *Daily Times*. When Ben's father died a couple of years ago Ben took over the family business, Zarren Motors in Belmont. Under Ben's guidance the place has thrived despite the recession. It is an AMC/Jeep/Renault dealership which has broadened out into rentals. The company has a loyal work force, with a couple of salesmen who have been with the firm for more than 25 years. On the side, Ben is on the board of directors of the Belmont School of Music. . . . **Bernie Goldhirsh**, you may recall, started *Sail* magazine a couple of

years ago, made it a success, and sold it. Running *Sail* convinced him that small business men were not well served by *Fortune* or *Forbes*. A struggling start-up firm doesn't care about gold prices in Hong Kong, it needs help. Bernie gave it to them in a magazine called *Inc*. It has been a great success, and two new magazines have arisen out of the Goldhirsh brain: *Technology Illustrated* and *High Technology*. They are doing very well.

John Deutch was a member of President Reagan's Commission on Strategic Forces, the group that reported on alternative MX missile basing plans last April. Shortly after the report came out John had a short article in the *Boston Globe* defending the panel's conclusions. The principal arguments for the missile were more psychological than technical. Deployment of the MX would send a strong message to the USSR while non-deployment would send a weak message. On the technical side the MX, having a greater payload, could carry sufficient decoys to fool even the most sophisticated Soviet ABM system. John's major point was that accepting the panel's other recommendations (Midgetman, and other warhead missiles) without MX deployment would greatly weaken the prospects of eventual arms control agreements.

Massachusets Secretary of Transportation **Fred Salvucci** has been busy trying to resolve a controversy about building a new Boston Harbor tunnel. As you might expect there are strong partisans for nearly every possible point of view. Fred has been taking weekly trips to Washington to try to get Congress to delay an autumn deadline on the decision while he tries to get consensus up here. . . . **Alan Cohen** a neurologist in Orange County, Calif., is head of neurology at five county hospitals and an assistant professor of neurology at University of California, Irvine. These days he is particularly wrapped up in computerized tomography and NMR methods of neurologic diagnosis. . . . **Haskell Rosenthal** writes that he is now professor of mathematics at the University of Texas, Austin. . . . **David Pratt** was director of systems manufacturing at Intel for nearly seven years but now has left and gone off to Boschert as senior vice-president of operations. . . . **Paul Fricke** works at the Illinois Co. running the investment management division.

Finally I'm sorry to have to report a death in the class, that of **Arthur Hatch** a year ago. I will try to get further information.—**Andrew Braun**, Secretary, 464 Heath St., Chestnut Hill, MA 02167

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A newsclipping I received tells of a race last April for selectman in Ashby, Mass. One candidate was **Herbert Bates**, who is a senior scientist with Energy Materials Corp. in Lancaster. He has served on the board of health, and he and his wife Susan are active in community affairs. Because the article was written prior to the election, I have no result to report. . . . **Carl Bauer** has been named manager of employee relations and capital construction projects for the Michigan Division of Dow Chemical Co. . . . **Peter Canepa** writes that he enjoys the travel associated with his new position as director of international marketing for I.T.T.-Gilfillan. . . . **Michael Kornitsky** has left his job with the Army Materials and Mechanics Research Center and now works for the Sikorsky Aircraft Co. division of United Technologies Corp. as manager of manufacturing technology. . . . **George Meyer** is now chief of medicine at Wilford Hall U.S.A.F. Medical Center. He has lived in San Antonio since August 1982 and would like to hear from anyone passing through. His children are Robert (13) and Elizabeth (11). He mentions that **Larry Pitts** and his family will be in England on sabbatical this year. . . . A brief report from the *Wall Street Journal* states that **Barry Roach** has resigned as chief financial officer of Shaklee Corp. No information is given on his current situation. . . . **Marshall Singer** was on sabbatical leave from the University of Pittsburgh last academic year, acting as a consultant in Washington, D.C.—**John Prussing**, Secretary, 2106 Grange Dr., Urbana, IL 61801

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"With all the broken parts (among our bodies), you could put together a corpse."—**Frank Modell**, speaking somewhat hyperbolically at our Reunion this past June 10-12.

We're all a little grayer, but more self-possessed than when we graduated 20 years ago. And maybe we are a little rusty with Maxwell's Equations, especially in differential form, but we've also got a broader perspective on life. At least those are my impressions of 42 of our members, as we gathered with our families at a "harbor club" at the elbow of Cape Cod. The most notable events were selection and installation of officers (taking three minutes), a reproduced-from-recording restrospective of the 24 or so years we've known each other (three hours), and a monumental beer-and lobster pig-out (an earlier three hours). Longest trips to the Reunion: **Morihiro Myodo** from Japan and **Harold Solomon** from Hatem Mostafa, Egypt!

More about the new officers—they are: president; **Jack Lynch**, vice president; **Jim Evans**, treasurer; **Pete Van Aken**, class agent; **Tony Doepkin**, secretary; **Phil Marcus**. I have to admit, as your new secretary, that I obtained this powerful (?) office via a shameless bribe—I now owe my chief competitor, **Warren Sewall**, a hamburger and fries from his favorite restaurant at Harbor Place, Baltimore. Incidentally, Warren is now practicing radiation medicine near Philadelphia, but I think he misses his sports-car racing days at the 'Tute. I believe it is in the interest of our class to stake out a respectable portion of the class notes insert in *Technology Review*, if necessary by elucidating at length my views on a variety of world problems. So keep those cards and letters coming.

Speaking of elections, **Billy Murphy** is running for Mayor of Baltimore against a strong incumbent. . . . Our own **Woody Bowman** was re-elected to the Illinois House of Representatives, and is chair of the Appropriations Committee. He got 63 percent of the votes.

Harry Koons is a senior scientist at Aerospace Corp., El Segundo, Calif. But his first love is Atari-800 software. He won Atari's Star Award, for *Mapware*, *Starware* and *Astrology*. . . . From Mill Creek, near Seattle, comes word of **Herb McClees, Jr.**, who lives there with his wife, Bonnie, and a "very active" 4-year-old, Johanna. He is an internal consultant with ELDEC Corp., involved in both organizational development (quality circles) and computers (FORTH language). . . . **A. Truman Schwartz** is at Macalester College, where he was recently named DeWitt Wallace Professor of Chemistry.—**Phil Marcus**, Secretary, 2617 Guilford Ave., Baltimore, MD 21218

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Greetings, '64. The mailbag is full and, I might add, we have a pretty successful group of classmates. Reunion is on track; let's make the 20th the best yet.

L. Patrick Gage has been promoted to vice-president, recombinant DNA research at Hoffmann-LaRoche, Inc., Nutley, N.J. . . . **Ned Block** has been promoted to full professor at M.I.T. in the Department of Linguistics and Philosophy. Professor Block has been a central figure in the development of inter-disciplinary research in cognitive science at M.I.T. He was president of the Society for Philosophy and Psychology in 1979-80. . . . **Bruce L. Chrisman**, head of Business Services at Fermi National Accelerator Laboratory in Batavia, Ill., has been appointed vice-president for administration at Yale University.

Elected to the National Academy of Engineering of the United States of America was **Lawrence R. Rabiner**. He is supervisor, Acoustics Research Department, Bell Labs in Murray Hill, N.J. He was elected because of his contributions to digital signal processing and speech communications research. . . . Oregon Bank has promoted **Michael R. Hale** to vice-president of electronic data processing (EDP) systems research and development. . . . **Clarence W. Malick** has been promoted to vice-president, Assistant General Counsel for ITT Consumer Financial Corp. He will assist in the legal affairs of the corporation as well as those of Thorp Sales Corp., an auction subsidiary of ITT. . . . **Douglas A. Haith**, an agricultural engineer in the New York State College of Agriculture and Life Sciences at Cornell University, has been promoted to full professor.

EG&G Geometrics has announced the promotion of **Bruce E. Crocker** to president and division manager. He will assume general management for the company. . . . **Mark Ordower** is now a partner in the law firm of Shepp, Hellmann and Ordower, which specializes in the legal problems of businessmen. . . . **Jay Tenenbaum** has been appointed to the Air Force Scientific Advisory Board. He is also scientific consultant to "The Software Fund," a limited partnership investing in R&D ventures involving development of software for personal computers and related applications. . . . **David F. Freeman** is working in communications theory at GTE Sylvania. He has two daughters.

Thomas H. Baker writes that Loveland is in Colorado, not Texas. Sorry about that!! Also, he has been working on in-house software tools for IC design. . . . **Martha H. Redi** writes that after postdoctoral work at Princeton University's physics department and GFDL, she has joined the Plasma Physics Laboratory. She and her husband, Olav, have a 12-year-old son. Olav is with the Physics Department at New York University. . . . **James Linderman** is assistant professor of computer information systems at Bentley College in Waltham, Mass. and president of Management and Computer Consulting Corp. in New Hampshire.

Roger K. Lewis is teaching architecture at the University of Maryland and writing a book and some articles. His wife, Ellen, was just appointed assistant general counsel at the Department of Commerce. The Lewises have one child, Kevin (9). In their spare time, they do much sailing between Annapolis and Bar Harbor, Maine, plus skiing, swimming, and tennis. . . . Last Fall, **Lester L. Hendrickson** attended the Harvard Advanced Management Program. In February he became director of planning for the Advanced Information Systems Division of American Bell, the new subsidiary of AT&T. His son, Brady, is a sophomore at George Washington University, studying photography. His daughter, Leigh, is in high school in honors English/journalism and playing soccer and lacrosse. . . . **A. Glenn Stith** is director of Computer and Process Control Services for Amoco Research Center in Naperville, Ill. He's active in the Presbyterian Church and also is a director for an alcoholic rehabilitation center. He enjoys family, golf, basketball, and bridge. His wife, Susan, is a Mary Kay beauty consultant and an active mother to their daughters, Shannon (12) and Heather (10).

James I. Lerner has been very busy this past year establishing a renewable energy venture, Wind Developers, to develop wind farms; that is, clusters of wind-turbine generators sited in windy areas to generate electricity and sell the electricity to the local utility companies. . . . **Joe Kasper** is continuing as director of SLBM Programs at TASC in Reading, Mass., and has been doing lots of traveling—about 60 percent to Washington, the rest to California. He and his wife, Pat, continue to reside in Andover, Mass. where Pat is teaching pottery and 3-D design at Andover High School. Joe has become an avid soccer-person. He plays in an over-30 soccer league and referees various youth soccer programs. His children, Jennifer and Becky, are in the 7th and 5th grades, respectively and are still really nice kids, even though they have started to call their father "Old Geezer"! Joe also mentioned having helped several classmates celebrate the big 40th.

Brian Kashiwagi is on assignment to Al-Jubail Petrochemical Co., an Exxon-Saudi joint venture which is building a polyethylene plant in Saudi Arabia. He is located at an Exxon plastics plant east of Houston, where they are training Saudi engineers and technicians. He has been visited in Houston by **Frank Chasen** who took a break from

the cold Boston winter where he is practicing law. Frank also visited Jackie and **Mark Kovacs** in Houston where Mark is a physicist with Exxon Production Research. Thanks, Brian, for the news of other classmates!

So much for the news releases and the alumni fund envelopes—bless you all and keep them coming! We had so much info for this issue, I am going to save a super class hero letter from **Bob Howie** for a leaner month. Do let me take this opportunity to mention, however, some data from **Steve Glassman**'s note. Steve and Lois have their first child, Laura Elizabeth, 7 pounds and 4 ounces, born this past March 23. Steve has recently worked on some Three Mile Island litigation but now is changing his focus to new technology and technology transfer-related legal issues. He continues as a partner in the Park Avenue law firm of Kay, Scholer, Fierman, Hays, and Handler. Steve suggested that I entertain consideration of another term as class secretary. Let me say this about that: I follow the noble and prudent example set by **Ron Gilman**: Ten years is ENOUGH!

Today is July 17. Our "baby," Lewis, is 11 today. We spoke to him from camp today and next week we visit him in Maine. George has shifted to private school for 9th grade after a turbulent 8th grade in the public school system. I am now a corporate vice-president with ManTech International, and Marlene continues to love the travel agent business.—**Steve Schlosser**, Secretary, 11129 Deborah Dr., Potomac, MD 20854

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I seem to have missed September, mostly through a combination of a late return from a business trip to St. Louis and sloth. The good news is that two months makes a healthy column for October . . . so here goes.

Pat Dawe writes that he is a principal with the Arroyo Group, a Pasadena-based architecture, planning and development services firm involved in economic revitalization, urban design, and city planning throughout the Southwest U.S., primarily in Southern California. . . . **John Tracy** says that after almost nine years at the Rockwell Science Center in Thousand Oaks, Calif., he has accepted the position of vice-president—advanced development for Talandic Research Corp., also in Pasadena. The company does optics and electro-optics design and manufacturing. His sons Tom and Chris are now 12 and 16 and are doing great. . . . **Mary Coffey** joined Bechtel as a senior consultant in their Environmental Services Department at the beginning of this year. She says that she is becoming familiar with the San Francisco area and that it reminds her of Boston, but she could do without so much rain. Mary's note said that she hoped to get into wine country soon. . . . The first line of **Tom Van Vleck**'s note was, "When will the rain stop?" Tom is still enjoying Tandem (also in the Bay area) and the beer on Friday. He wonders, "If beer had not been discovered would we have the computer now?"

Zack Lansdowne is working at Rand Corp. on logistics problems for the military. He also has completed a book on philosophy that is to be published this year. . . . **Jim Sprinkle**, at the University of Oklahoma, had a major monograph on fossil echinoderms published by the University of Kansas in August of last year. The monograph completed eight and a half years of work. In October of last year, Jim received the Schuchert Award of the Paleontological Society at their annual meeting. He was promoted to Professor in December, effective last month. Jim says it was a good year. I guess so! . . . **John Edgar** writes that he will be promoted to colonel in the Air Force (I think) around December, and in September became dean of research and information at the Defense Systems Management College at Fort Belvoir, Va. John was director of research before becoming dean. . . . **Herb Mower** has moved and started a new job at Danbury Hospital in Danbury, Conn. . . . **David Trevett** writes that his entire family is affiliated with the University of Chicago. David is project manager for data base management systems for the University's computer center; wife Melissa is one of six Council on Library Resources Fellows in a special program on library management in the Library and Business Schools; and son Philip is in the University's lab school nursery.

A few pieces of family news this month. **Lou Kleiman** reported that in April he married the incomparable Cindy Levines. They went to Hawaii for a honeymoon, then Cindy returned to Capitol Hill and Lou to commuting from Washington to Fullerton, Calif., where he consults for Hughes Aifcraft on the F.A.A.'s upcoming Advanced Automation System. . . . **Michael Weiss** reports that on February 20, he married Sandra Anderson of Dallas and is now a husband and father for the first time. Michael has three stepchildren, one studying architecture at Texas Tech, one at Texas A&M, and the third a senior in high school. The family is completed by Sandy's dog and Michael's cat. Michael pointed out that he hasn't written in ten years, but might not wait so long next time. . . . **Dick Tsien** writes that he and Julia were surprised and delighted at the birth of a son, Gregory, on January 2. Sarah, their first child, is 3 and very proud of her brother. Dick says that his research is exciting, but so are the challenges of juggling two kids and two careers.

Walter Miller has been promoted to associate professor of pediatrics at the University of California, San Francisco. He does some clinical work, but devotes most of his time to cloning genes for adrenal hydroxylating enzymes and editing a new journal, *DNA*. Walter has found a new use for his "expensive high-falutin' education." He and a few inebriated friends have been making wine. He says the Pinot Noir and Cabernet are great; the Chardonnay is horrid. In vino, veritas. . . . **Channing Stowell** writes that he and Margy live in Barrington, Ill., since moving there from Minneapolis eight years ago. They have two children: Julie (12) and Channing Werner (9). Chan has had his own Marketing Information Technology Applications business for one year. He says the direction of his life has changed completely since he took training two years ago, and he highly recommends the EST training. . . . **Dick Bator** is now an independent software consultant, doing programming projects on DEC hardware. He mailed me a clipping from the *Boston Globe* about the topic of taking the kids when you go out to dinner. It included an interview with Diane and **Dick Schmalensee**. (They mostly leave the kids home, though they sometimes take them along.)

So happy fall, folks. Its July as I write this, and Anne and I will probably go canoeing tomorrow.—**Steve Lipner**, Secretary, 6 Midland Rd., Wellsely, MA 02181

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My fellow civil engineer, **Bob Curd**, is currently attending the Executive MBA program at UCLA and will graduate in June 1984. . . . **Malcolm Wheeler** is also in Los Angeles where he is a partner in the firm of Hughes, Hubbard, and Reed. In 1982 he served as chief counsel to the Senate Select Committee to study law enforcement undercover activities. . . . **Roy Levitch**, his wife Janine (former "techretary" in Course X) and sons (Mary, Brian, and Barry) love living in Phoenix. They have been there since the fall of 1981 when Roy became business planning manager of Solavolt International, a solar energy joint venture between Shell Oil and Motorola. . . . Congratulations to Beverly and **Arthur Boyars** on the birth of their twins (boy, Jacky and girl, Dova) in March 1983. Arthur mentions that he saw Marc Vogel in Pittsburgh. The Boyars are living in the Kemp Mill area of Silver Spring.

Alan Steinman is currently serving as medical advisor to the chief of Search and Rescue in Coast Guard Headquarters. He is engaged in research in operational medicine in the areas of hypothermia, survival, and life support systems. . . . **Ed Seymour**, who was with us for the SE program in the fall of 1966, is now retired but doing consulting and technology management and writing on defense and aerospace issues. He would like to hear from other SE program graduates. . . . **Paul Ruby** of Longmeadow, Mass., is co-founder and president of a new investment banking firm, Parker, Benjamin, Inc. in Bloomfield, Conn.

M. David Egan was elected vice-president of the National Council of Acoustical Consultants and has published "Concepts in Architectural Lighting" and "Concepts in Building Fire Safety". . . . Leonore ('69) and **Carl Jones** sent a note full of news and questions. Carl continues to manage a development organization for Tymshare, Inc. in Coopertino, Calif., and Lenore still works for Research Library's Group at Stanford. Their son Matthew is 6 years old and Karen is now 3. They see several other couples who are Tech grads—Mike ('68) and Linda ('67) Tashker and Carl ('68) and Lynn McClure ('70) Rodoni. The Jones asked to hear from **Tom Ellis**, **Henry Seltzer**, and **Mike Gable**.

Your secretary was named adjunct assistant professor of business administration at Suffolk Community College. I have been teaching there one night a week for several years and enjoy it greatly. Please send news; the mailbag is empty.—**Joe Shaffery**, Secretary, 34 Hastings Dr., Ft. Salonga, NY 11768

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David Schramm was named to the Louis Block Professorship in the Physical Sciences at the University of Chicago. He is still chairman of the Department of Astronomy and Astrophysics and professor in the Department of Physics at Chicago. . . . **Larry Burgess** completed his Ph.D. in systems engineering at the University of Pennsylvania in 1981. After ten years with Magnovox, he is now chief engineer at Flam and Russell, Inc., an expanding antenna and microwave engineering company. He and his wife were expecting the birth of a daughter in August. . . . **Joe Revelli**'s first child, Joseph Christopher, was born January 14. Joe is working at the Xerox Webster Research Center on electro-optic devices and electronic printers. . . . **John Howard** is vice-president of manufacturing at Durakool, Inc. in Elkhart, Ind.

Alan Hirsch is now working in the computing and information technology group in strategic planning and technology assessment for Standard Oil of Indiana. He is also director of District 8 for Tau Beta Pi. . . . **Richard Vaughan** is assistant vice-president with Marsh and McLennan Group of Associates of Chicago and has received associateship designation in the Casualty Actuarial Society. He and his wife Gee Gong live in Highland Park. . . . **David Kiddder** has been appointed director of sponsored research and associate professor of management at Babson College in Babson Park, Mass. . . . **Lawrence Rabiner** has been elected to membership in the National Academy of Engineering in recognition of his contributions to digital signal processing and speech communications research. He is supervisor of the acoustics research department at Bell Laboratories in Murray Hill, N.J. . . . Laura and **Gerald Marandino** left in August for the American Institute in Taiwan to study Chinese for a year. Next summer they will be on their way to Beijing, where he will be general services officer in the U.S. Embassy. Any classmates passing through Beijing from August 1984 to June 1986 should stop by.—**Jim Swanson**, Secretary, 878 Hoffman Terrace, Los Altos, CA 94022

69 15th Reunion

Most of our classmates report growing families, as well as career advances. **Richard L. Partridge**'s son Gregory was born this May, new brother to 3-year-old Amy. Richard is doing large-scale processor engineering with IBM in Poughkeepsie. . . . Also born in May was David Lawrence Asman, son of Sheryl and **Sanford J. Asman** and brother to Gregory Paul (8) and Ilyssa Nicole (6). The Asmans

live in West Trenton, N.J., and Sanford is a patent attorney with Squibb Corp. in Princeton, handling the work of their medical electronic subsidiaries. . . . **Christopher R. Ryan** reports from Pittsburgh that new son Peter Dacey, born last August, joins Patrick Hudson in "teaching his parents the *real* facts of life." Lou and **Josette Capriles Goldish** have been in Newton the last 12 years and have two children: Andy (11) and Suzy (8). Josette will be getting an M.S. from the Sloan School in 1984. . . . **Paul Abbas**, who has been teaching at the University of Iowa in Iowa City since 1974, has three daughters. . . . **Roger Chang** lists his family as his "lovely wife Lula, sons Daniel and Michael, German Shepherd Juno and cat Abby." The Changs live in Columbia, Md., where Roger is manager of electronic warfare programs at Westinghouse, vice-president of the Chesapeake Bay Roost of the Association of Old Crows (an electronic warfare professional society), area governor of Toastmasters, and a major in the U.S. Army Reserve.

Since last year **Mohan Munasinghe** has been senior energy advisor to the president of Sri Lanka and chairman of the National Computer Policy Council of Sri Lanka. . . . **Sam Polanco** has been a member of the technical staff of Bell Laboratories at Allentown, Pa., since 1978. For the last two years Sam has been responsible for the deposition of tantalum-silicide films used in Western Electric's V.L.S.I. circuits, such as a 256k dynamic memory and a 32-bit microprocessor. . . . **Dennis Spurgeon** is now group vice president of U.N.C. Resources, Inc.—responsible for all manufacturing activities, including naval reactor cores, machine tools, and aerospace components, as well as the operation of the Hanford "N" Reactor under contract with the U.S. Department of Energy.

Donald J. Collins is now in Marshfield, Wisc., where he has started a private practice in obstetrics/gynecology, having completed his obligations to the Indian Health Service. . . . **Monib Khademi** lives in San Francisco; he reports, "I am responsible for a seminar program that has 40,000 people participating in it around the world, currently. My love to all my classmates." . . . **Paul Bannister**, who is living in Los Altos, Calif., is looking for **Ernie Hynes**, whose address we do not have, but who is reportedly also living in Silicon Valley. Information regarding his address would be appreciated.

My publishing businesses have been going reasonably well. We recently did a 1,000-copy illustrated, signed edition of Stephen King's bestseller *Christine*, and by the time you read this the production of a limited edition of **The Talisman** by King and Peter Straub should be under way. Don't forget our 15th reunion next June, and keep sending in those letters.—**Robert K. Wiener**, Box 27, M.I.T. Branch, Cambridge, MA 02139

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H.J. Siegel is currently a professor in the Electrical Engineer School at Purdue University, doing research in the area of parallel/distributed computer systems. . . . **Robert Rozenberg** reunited with his old roommate, **Norman Kohn**, in Chicago. Robert is in practice in Internal Medicine in Skokie, and Norman is a neurologist at Mt. Sinai Hospital. . . . **Neil L. Ross** and his wife are both eye surgeons in private practice in DeKalb. They have a one-year-old boy named Michael and another child on the way. . . . **Jaime Olmos** joined Southern California Edison and is working as a computer/nuclear engineer at San Onofre Nuclear Generating Station with the nuclear training division on a Singer-Link site-specific Songs-2 Simulator which is driven by two Sel 32 computers. . . . Congratulations to **David A. Hodges**, professor of electrical engineering and computer sciences at University of California, Berkeley, who was elected to membership in the National Academy of Engineering for his innovative contributions to integrated circuit design techniques and their application to data and signal processing. . . . **Adrian Bejam** will open the Multi-Phase Flow and Heat and Transfer Symposium/Workshop with his keynote address on the Second Law Aspects of Heat Transfer Engineering. Adrian is a professor of mechanical engineering at the University of Colorado, Boulder. . . . Congratulations to **Andrew Lippman**, who has been named as an associate professor at M.I.T. He directs the Architecture Machine Group and has contributed importantly in his work to the field of interactive computer graphics. He has worked on the development of frame buffer graphics and on optical video discs, and most recently has been involved in the creation of a new field: computational video. . . . **Martin Silfen** has opened his own legal practice in Atlanta, Ga.—**Hal Moorman**, Box 1808, Brenham, TX 77833-1808

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Lee Brown writes that he is enjoying teaching, research, and clinical work in pulmonary medicine at Mt. Sinai in New York City. He has a 10-month old son, Matthew Ian, who is a delight and another little person due in December. . . . **Darrell Rigel** was recently appointed a clinical instructor at New York University Medical School and director of dermatology at the Preventive Medicine Institute, Strang Clinic, in New York City. . . . **Richard Solbrig** is married and the father of a 4-year-old girl and a 2-year-old boy. He is a project manager for John Cavollo Engineers in Walnut Creek. . . . **Mark Koenigsberg** is in the Business Analysis System Center at Bell Labs in Murray Hill, N.J. and wants to know the whereabouts of "the Burton House Fine Fifth, **John Sullivan**, **Paul Lentricia**. Get in touch (201) 582-5211 (office) or (201) 966-1009 (home)." . . . **Peter Haeffner** is president of Lehman Realty Corp., the real estate investment arm of Lehman Brothers, Kuhn, Loeb.

Robert Richmond reports, "I'm leaving a good job and great salary to take a big chance—starting my own software company. Anyone who's interested in the Seattle area or who would like to lend some advice please drop me a line." . . . **David McDonald** writes that he is "settling into the professor's life out at the University of Massachusetts, Amherst and started doing consulting in artificial intelligence and natural language processing. Life is good." . . . **Chris Stickler** retired from the navy last November and is happily settled in Orlando, Fl., commuting to the Kennedy Space Center where he is a senior engineer at McDonell-Douglas involved in space shuttle operations.

Richard Scordato reports, "My wife, Susan, and I had a beautiful daughter, Eizabeth, in October. Susan is doing free-lance architecture and I am vice-president, engineering for Medical Laboratory Automation. . . . We hear from **Glenn Rowsam** that he is "still working for the New York State Department of Social Service as a programmer currently designing and implementing database applications. I started skiing this past winter and am now editor of a local ski club's newsletter. Ski club name? The OCs for out of control." . . . **Charles Gronauer** writes, "After a year as president of the Florida Magicians Association, I will take on the more permanent position of secretary/treasurer. I'm now president of the M.I.T. Club of Palm Beach County, and I just opened a new store which sells newspapers, books, magazines, etc. in West Palm Beach."

Finally, I had dinner at Durgin Park recently with Robert ('70) and **Margaret Rondio Turek** and their very active sons, Benjamin and Daniel (the most fearless 3-year-old on a slide that I have ever met) along with **Don Levinstone** and Bern Krafsig, '71, and his family. Robert and Margaret live in McLean, Vir. and are both working half time and taking care of the kids half time.—**Dick Fletcher**, Secretary, 135 West St., Braintree, MA 0214

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I received a few letters this month to pass along to you. **Lee Giguere** wrote a long letter to me; he was at the reunion in June, and saw **Michael Federow** and **Joel Bergman** there among the 100 attendees. He enjoyed meeting those he did not know as well as old friends like **Steve Taylor**, with whom Lee and family spent time. Steve had news of former president **Bob Longair**, who is a university professor in Sydney, Australia. Lee mentioned returning to Jacob Wirth's restaurant in Boston to show it to his wife Gina, saying that he had not been there since my June 10, 1973, wedding. I fear I spent June 10, 1973 doing something other than getting married. Lee has written me a few times, and I hope I'm not being confused with someone else.

It has been a decade since graduation, and reunion was pleasant, I'm told. About 70 attendees were class members; they and their families were treated to an M.I.T. reception, a roller skating party, picnics and brunches. Class elections were held; the results were: **Sze-wen Kuo**, president; **Steve Taylor**, v.p.; **John Chandler**, treasurer; and yours truly, reelected in absentia as secretary. A number of class superlatives were recorded and are hereby dutifully reported. Traveled farthest: 3-way tie—**Joel Bergman**, **Carl Rosenberg**, and **Debra Judelson**. Same job since graduation: **Philip Fuhrman** (H.P.). Most jobs: **Lynn Snyder** (seven and still looking). Longest marriage: **Fred Gross** to Laura (11 years). Most recent marriage: **Debra Judelson** to A.J. Willmer (May 15, 1983). Oldest child: Akiva (son of **Ron Holzer**). Youngest child: **Ken Rosato**'s 4-month-old. It's a good thing I didn't attend; I'd have copped oldest child (Eric is 9 1/2) and most jobs (nine). Thanks to the Alumni Office and the Reunion Committee and, of course, the classmates.

Richard Bratt has been appointed director of software engineering for Spinnaker Software of Cambridge. He will be responsible for learning games for home and school microcomputers. **Frank Keil** is now associate. professor of psychology at Cornell. . . . **David Storeygard** is a senior associate in architecture at Perry, Dean, Rogers and Partners of Boston. . . . **Sylvia Weatherford** was keynote speaker at the Blacks in Engineering banquet in Phoenix. . . . Marilyn and **Alan Lawee** produced Alison Lia on May 19, 1982. . . . **Ronald Gittelson** and new wife Margrit have an old farm house in Lancaster, Mass. . . . Ruth and I are building.—**Robert M.O. Sutton, Sr.**, 24 Princess Anne Ct., Warrenton, VA 22186

74 10th Reunion

Welcome to a brief but meaningful column of class comings and goings. We have a reunion coming up sooner than you think, so make sure your summer of 1984 plans include Boston in early June. If you've got an idea or suggestion that you want to see implemented, write us right away and tell us about it. If you think a Boston trip is just too far to go, we can provide you with the names of classmates in your geographic area as well as the whereabouts of classmates you may have lost track of and want to get in touch with again. Reunion means to come together, so let's do just that.

Jon Einsidler became vice-president in charge of the corporate finance department at Erus Partners Securities Corp. in the Big Apple. He says the rest of his life is still the same, "single and jocking it up."

News from **Tom Wolf**: Tom's a research chemist at Amoco Chemicals Co., exploring ideas in new chemicals production. In his free time he's playing soccer and ice hockey, two sports he brought with him from M.I.T. He's also taking clarinet lessons and playing happy homeowner with his new house in suburbia. . . . After graduating from the University of Texas Law School in 1977, **Tom Jones** began practicing real estate law in Houston. He's working in the firm of Walsh, Squires and Tompkins, and has also been on the M.I.T. educational council since 1977. . . . Did you know that more wood is used in the U.S. than all other construction materials combined? **Dave Gromala** sends in this bit of trivia to highlight the fact that after eight years of doing wood engineering research at the U.S. Forest Products Laboratory, he wants to know why there aren't more Tech

grads in the field. Write him at P.O. Box 5130, Madison, WI 53705. . . . Mr. and Mrs. **Mark Schneider** recently bought a house in Rockville, Md., and are now up to their necks in mowing, painting, repairing, and all the other "joys" that go along with supporting a home.

Condominium living is truly a double-edged sword, writes **Derrick Vlad**. He's president of the board of directors of a condo in the midst of being turned over to owner control. Derrick is now living in Coral Gables and working in Miami as manager of corporate planning for Ryder System, Inc. . . . **Bruce Barton** has recently become involved in late model stock car racing as a driver and owner. He hasn't given up his interest in technical mountaineering either. As vice president of commercial development for Developers Group, Bruce is responsible for retail and office development in Las Vegas and casino and resort community development in Laughlin, Nev. . . . **Michael Grovak** has recently moved from Chicago to the Mile-High City of Denver, where he's working as senior service planner for the Denver Regional Transportation District. . . . Congratulations are in order to **Beverly Wilson**, who recently added motherhood to her list of careers with the birth of a daughter, who has already cost Beverly more all-nighters than she ever put in at the Tute!. . . **John DiLoreto** finished his degree program at the Stanford Graduate School of Business in June and is still enjoying himself as head of his own start-up firm, Silver Label recording . . . That's it. Think Reunion!—**Lionel Goulet**, 21 Melville Ave., Dorchester, MA 02124

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It is my sad duty to report the death of **Mark Preissler**, after a long illness. Our sympathies go out to his family.

From the reading of the national newspaper, *USA Today*, I learned that **Mike McNamee** is their money reporter. Congrats. . . . **Mark Koupal** sent word that after five years of public accounting, he's moved on to become controller of Spectrum Laboratories. He says, "I now have offices in Los Angeles, Houston, Chicago, and New York. I love the traveling (I've already started commuting to Houston once a month), but it's still great to come back to California." . . . From **Fred Walter**, "Still in Colorado, enjoying the summer (snow) skiing season.". . . **Harvey Berger** sent a laconic note: "Graduate, University of San Diego School of Law, December 1981; Admitted, State Bar of California, June 1982; Employment, Attorney, McInnes, Fitzgerald, Rees, Sharkey, and McIntyre, San Diego, Calif." . . . **Robert Granetz** writes, "After graduating, I joined the scientific research staff at M.I.T. and I am working in the field of plasma physics and magnetic fusion energy." . . . From **Patricia Schettig**, "I'm still alive and well, living in West Virginia, and working for the U.S. Fish and Wildlife Service as a wildlife biologist."

Additions. Esther ('79) and **Jeff Jaffe** "just added David Arthur to their family on May 10, 1983, joining Yaakov, Age 2." Jeff is currently manager of the Network Architecture group at IBM's research facility at Yorktown Heights." . . . And from **Jordan Wouk**, "Our 3-year-old son is a gem. He has made his first self-referential sentence. I'm now the manager of system development for Guardian Life in New York."

Partha Ghosh participated in writing articles for *Technology Review* and *Sloan Management Review* on technology management and on Japanese art in management technology." . . . From **William Grace**, "I'm programming HP-85s for a living. I'm attending Bible College for the love of God. I'm investigating the application of computer technology to the pursuit of Biblical studies." . . . **Reynold Lewke** writes, "After three and a half years in downtown New York, I have trekked northward to Connecticut to return more closely to my AA roots and joined the legal department at Sikorsky Aircraft Division of United Technologies as senior assistant division counsel." . . . **Deborah Stein Sharpe** writes, "Working for a small auto supplier as an account manager. Also trying to develop a non-automotive product. My husband Jim has just started a job 150 miles north of our home, so for the third time in our relationship we are a commuting couple. . . . From **Jeslie Chermak**, "Seems to have been a quiet year. Not much happened. Met Eric Black, '77, at Micro 15 conference in Palo Alto last October. Almost met **Joe Abeles** in San Francisco, fresh from school with his new doctorate. Started playing Dungeons and Dragons (a role-playing game that seems to attract a lot of former M.I.T.ers). Met some "filkers" (science fiction varients on folk song singers) and a real live (serious) witch! Am finally getting it together to tramp through Europe. Like I said, a quiet year."

Wesley Van Voorhis got his Ph.D. degree from Rockefeller University in June 1983. He is now also an M.D. student at Cornell University Medical College in New York City. His Ph.D. studies involved a type of white blood cell, a dendritic cell, and its role in the immune system, especially in graft rejection. . . . **Peter Hagelstein** writes, "Still at the Lawrence Livermore Laboratory, currently in the capacity of a computational physics group leader and principal project scientist in the lab's recently formed R-program. I have of late been involved in efforts to develop laboratory EUV and soft x-ray lasers in collaboration with a group in the local laser program as well as a collaborative LLNL-Rochester Laboratory for laser energetics effort. I'm curious as to what became of my old Connor 5 buddies. I enjoy recounting some of the war stories of the year in a quaint neighborhood in Jamaica Plains, the pet bat, etc. I have been basically out of touch with my friends from M.I.T.—can't say that I've seen anyone from the Class of '76 lately. Livermore does have quite a few old M.I.T. people around who I see from time to time."

Ron Pisaturo is the president and CEO of a new educational effort, the American Renaissance Schools, Inc. The school's educational philosophy is the emphasis on using reason in all areas of one's life, whether it be for career or personal aspects. The approach is highly individualistic, with key underpinnings from Ayn Rand's philosophy of objectivism.

Your secretary spoke with **Mike Sarfatti**. Mike is now with Raychem in the Chemelex division, which is involved in manufacturing electric heat tracing products. He is no longer an engineer directly, having become a project manager, a transition we have both seen in many of our classmates. He also moved from the beach to the top of Russian Hill in San Francisco proper, and loves it.

As for your secretary, he continues to see stormy trading in stock index futures, precious metals, sugar, cocoa, soybeans, Forex and T-bonds. We continue to live in an era of unprecedented volatility, which, when coupled with leverage, gives some very interesting trading opportunities. On a personal note, I will be leaving Merrill Lynch Futures in New York to join Merrill's Chinese joint venture in Hong Kong as its vice-president, trading and markets. By the time you read this, I hope to be comfortably established on Hong Kong Island. In order to stay in touch, I will be setting up a U.S. phone number for a remote answering machine. When it is available, you will see it here. However, I do plan on remaining the class secretary and on occasion will be speaking with at least some of you via telephone. As part of this deal, I will be visiting most of the Pacific Basin, including mainland China and Australia/New Zealand. I do hope to see some letters to make production of our class notes a bit easier.—**Arthur J. Carp**, Sun Hung Kai, Merrill-Lynch Commodities, Ltd., 3rd Floor, Admiralty Centre, Hong Kong

77

Our news this month begins with **Howard Boles**, who is currently a software engineer of Applicon and has just celebrated his first wedding anniversary with his wife, Lisa, currently an associate producer with a Cambridge filmmaking firm. Howie and Lisa are both still active in the theater, having just finished two productions with the Harvard Gilbert and Sullivan Society. . . . **Renan Beckman Wills** will be completing her residency in July 1984 and then doing anesthesiology for another two years. . . . **John Lampe** received his Ph.D. in chemistry from Berkeley and is now a medicinal chemist for Berlex Laboratories in New Jersey.

Richard Ulene is currently engaged in a residency program in internal medicine at U.C.I. Medical Center and is living in Newport Beach, Calif. . . . **Mitchel Kling** is beginning his third year of psychiatry residency at the Hospital of the University of Pennsylvania. Mitchel will begin a fellowship at the National Institute of Mental Health next year and then, he says, "After that, I'll have to find a real job." . . . **Deborah Hoover Dobson** and her husband, Jeff, now have two sons, aged 4 and 2. Deborah is still working at Exxon Product Research on subsea systems. . . . **Thomas Mays** is currently manager for terminal development engineering at M.C.I. Telecommunications.

William Kaiser just graduated from Harvard Business School, and will be working for Apollo Computer in Chelmsford, Mass. . . . **Barbara Putnam** is working as a designer for David Harvard, Inc., in Alstead, N.H. . . . **Earl Bunker** is currently a manager for new business development at Digital Equipment Corp. Earl is living in Boston and "enjoying country living." . . . **Thomas Wylegala** completed his M.S. in computer science at Purdue and is continuing there toward his M.S. in electrical engineering in May 1984; he expects his wife, Helen, to graduate at the same time with a degree in industrial management.

Better late than never? I hope so. In late January, I lost a long-overdue letter from **Carol Catalano Martin** describing our 5th reunion. I now include highlights here: Libby and **Bill Baum** are working for Kodak in Rochester, N.Y. . . . **Steve Blatt** is in graduate school at Yale and doing research at Brookhaven National Laboratory. . . . **Norm Smith** is an attorney in Burlington, Vt. . . . **John D'Angelo** is working for Schlumberger in Denver. . . . **Christine Dowler** is working for the New York State Power Authority in New York City. . . . **Eliot Goldstein** is now an architect in New Jersey. . . . **Michael Gross** is in graduate school at Northwestern University. . . . **Leo Harten**, who ran for UMOC in 1977, is now president of Paradigm Associates, Inc., a custom software and numerical analysis firm, and is also a physics graduate student at M.I.T. . . . **Paul Hertz** and **Ninamarie Maragioglio** were expecting their first child (old news!), while Paul studied astronomy at Harvard and Nina studied psychology at M.I.T. . . . **Eric Lindstrom** was studying oceanography at the University of Washington in Seattle. . . . **Kevin Miller** and his wife live in Farmington, Conn., where Kevin is practicing psychiatry. . . . **Eriel Ramos** is working for the U.S. Geological Survey in Washington, D.C. . . . **Steve Schiff** is doing his residency in neurosurgery at Duke University. . . . **Charlie Shooshan**, our class president, recently received his pilot's license, and flies from his law practice in Connecticut to Boston occasionally. . . . **Richard Stone** is now a professor at Harvard Business School. . . . Marla and **Steve Spiro** live in Sherman Oaks, Calif., where Steve is an anesthesiologist. . . . **Debbie Stutman** is a graduate student at Lehigh University. . . . **Jeff Weiss** is working for I.B.M. . . . **Nancy Freeman** is doing her residency in Providence, R.I. . . . **Steve Wilk** is a graduate student in optics at the University of Rochester. . . . **Steven Bader** is a dentist in Boston. . . . **Chris Perley** is working for Hoffman La Roche Pharmaceuticals in New Jersey. . . . **Stuart Scharf** is working at Lincoln Laboratory and living in Sharon, Mass., with his wife and two children. . . . **Debbie Darago** and **Calvin Winey** were expecting a child. Calvin is working for Advanced Color Technology, and they live in Billerica, Mass. . . . **Marita Garginlo Holl** was married in 1981 and lives in Connecticut. . . . Other reunion attendees included: **Glenn Brownstein**, **Steve Buchtal**, **Craig Burch**, **Patricia Clark**, **Dave Dobos**, Ellen Silverman and **Stephen Green**, **Jonathan Herland**, **William Kaiser**, **Harvey Kaufman**, Linda Lampron and **Daniel Leighton**, Janice

and **Andrew Werber**, **Jed Furhman**, and **Elaine Tell**. I apologize for the delay in printing this news. Please let me know if the information is no longer current; I'll be glad to print an update.—**Barbara Wilson Crane**, Secretary, 6431 Galway Dr., Colorado Springs, CO 80907

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Well, we did it! We had a reunion—and it was an unmitigated smash. First and foremost, kudos to reunion chairperson **Karyn Altman** and her friend Ray, who served us up a great menu of food and events ranging from Chinese food and roller skating to barbeque and fancy luncheons and dinners. She did such a great job the consensus was to draft her for the tenth-year reunion. We had a total of 121 people at the various events (82 alums), which puts us near the record for fifth-year reunions and put us ahead of two of the more senior reunion classes. At her report to the class, Karyn reported that "the class is great on roller skates."

At one of the events I left out a sheet for classmates to write their own gossip. Here are some exerpts: **Vincent James** has left the Queen City (Cincinnati, at Procter and Gamble) to work in sunny Orlando, Fla., for a computer consulting company. . . . **Bob Reynolds** and **Dan Ebrom** just spent three weeks in Europe and Iceland. Bob's at B.B.N. in Cambridge, and Dan is a graduate student in geophysics at the University of Houston. . . . **Josie Stein** is at M.I.T. again, working on a Ph.D. in M.E.—and she is in a piano trio called the No Nukes Trio. . . . **Frank Murphy** managed to find the time not only to attend reunion, but to spend much of the weekend running around helping to organize things. That's pretty tough, considering Frank usually draws weekend duty as the youngest lieutenant in the history of the Cambridge Fire Department. Some of us already call him Commissioner. Frank and his friend Sharon had a great time. . . . **Steve Rice** had a great time at reunion too, thanks to the prodding of his wife Leslie Carey, '77. Steve is doing a chemistry post-doc at M.I.T. being supported by his architect wife. . . . More Baker folks: **Nivo Rovedo** and his wife Peggy came to reunion leaving their new house and garden near Poughkeepsie, N.Y. for the weekend. They stayed with **Jennifer Jonas Stahr** and **John Stahr**, who also just bought a house and garden—in Sudbury, Mass. . . . **Mary Kapus** came in from Southern California, where she is a facilities manager for a naval base.

I reported many months ago that **Alfred Wendolyn Chock** and Bonnie Mason, '79, were getting married in the then-near future. Silly me. The rumor got back to Bonnie's parents, who hadn't known. Well, to save my face, Al and Bonnie tied the knot just yesterday. They came to reunion and demonstrated their roller skating technique. Al is working as an engineer in Boston; Bonnie just graduated from Harvard Business School. . . . **Regina Wiedenski** got married (to Brian Backner, '79), went on her honeymoon, moved from New York to Boston, and came to reunion—all in about a week and a half. Regina is working as an investment consultant for a small Boston firm. . . . Regina's former suitemate, **Nancy Lukitch**, came up from New York, where she is a management consultant with McKinsey and Co. . . . **Beth Plasse** works for Shell Chemical in polymer sales in the Chicago area. . . . **Bob Asher** just moved back up to Boston, where he is working for a small patent law firm. . . . **Mitch Hollander** works for New England Nuclear, and he lives in mid-Cambridge with **Rich Zingo Zingarelli**. . . . **David** and **Gail Kahn** are living in a small house in Newton—with more computers than rooms. David is a manager for Wang; Gail is writing software and science ficton. . . . **Steve Perry** is still in Boston, working for a very fine small law firm in town. Steve still plays a mean game of poker, but we lawyers say it's practice for negotiations. . . . **Julie Keller** dropped in on reunion unexpectedly. She was on her way from hometown Minneapolis to Burlington, Vt., where she will do her psychiatry residency.

A few months ago, when I read the bestseller "The Soul of a New Machine," one of the names kept ringing bells. Yes, folks, one of our classmates has made fame: **Jonathan Blau** was the super microkid who helped to build Data General's new machine. Since then Jon moved to Sunnyvale, Calif. to work for Tandem Computers, and now he has just moved back to Massachusetts to work for a computer start-up firm, Dataflow Systems, in Acton. . . . **John Marcou** sent me a note and a picture from the wedding of his former roommate **Todd Buikema**. The picture is of John and Todd, as well as their fraternity brothers David Tokir, '79 (the bouncer), and George Todd, '76, the brother of the bride. (Unfortunately he didn't include the name of the bride.) John also reports that he and wife **Roby Rosen** have recently celebrated their first anniversary. Roby has just completed her internship in pediatrics at Stanford, and John just finished his first year of grad school in petroleum engineering.

Some new doctors: **Paul Okunieff** just became a double doctor, graduating from Harvard-M.I.T.'s M.D.-Ph.D. program. Paul is now a resident at Mass. General in Boston specializing in radiation medicine. When he can spare the time, Paul runs some marathons. . . . **Marc Weiner** is now a resident at University Hospital, specializing in emergency medicine. His wife gave birth to their first daughter this March. . . . **Jeanne Scott** is doing her internship in family practice at University of Massachusetts. She recently married **Patrick Barron**, who is working for Control Data Corp. while completing his masters in computer science. . . . **Jeannette Wing** writes: I'm *finally* leaving M.I.T. with a Ph.D. in Computer Science. I start teaching in the fall at U.S.C.'s Computer Science after a six-week jaunt in China this summer. I'm not fencing anymore, but instead have taken up ballet. Without all those dance classes I'd never have finished! . . . And, last and least among our new doctors is my fraternity brother and worlds best lasagna chef, **Earl Thomas Cohen**. Most of us thought that he would never make it, but Earl got his Ph.D. this June from U.C. Berkeley in Computer Science. Rumor has it that Earl plans to punt computers and open an Italian restaurant.

At reunion, we had elections for offices. The nominations committee (a.k.a. **Alan Presser**) scrounged for nominations as hard as he could, but he got stuck with this slate: Our "new" president is **Jim Bidigare**, who has consented to serve another five-year term. Jim has distinguished himself over the last five years as an outstanding class president, and has maintained an active participation in all levels of the alumni association. . . . We have a new vice president, **Debra Abbot Page**. Debra has worked hard in the last few months in helping to organize the reunion, as has our new treasurer, **Karyn Altman**. Karyn proved herself capable of handling reunion finances as reunion chairperson, so we all figured she could handle our regular books as well. . . . All of the above elections were unanimous. Mine, alas, was not. The one dissenting vote came from the "class clapper," Professor **Paul Lagace**, but, fortunately, he was quickly outvoted. I am happy to say that you folks are now stuck with another five years of my verbose ramblings—yes, I, **David S. Browne**, was reelected. (That's what you all get for not coming to reunion.) Keep those boring postcards coming folks. Have a colorful fall and a pleasant Indian summer. Send me your news and rumors.—**David S. Browne**, Secretary, 50 Follen St. #104, Cambridge, MA 02138 (617) 491-5313

79 5th Reunion

Your faithful secretary just returned from a two-week excursion to Italy with buddy Lori Ullman, '81. You know all those glossy brochures you keep getting from the M.I.T. Quarter Century Club? We took one of their tours, and it was great. The tours are run by International Weekends, a Boston-based charter organization. We visited Milan, Florence, Naples, Rome, Assisi, and Venice, plus many sidetrips (including Switzerland, the Italian Riveria, Capri, Pompei, Padua, and Verona). If that sounds like a lot to do in two weeks, you're right. We came back exhausted but happy. We only met a couple of others on our tour who booked it through M.I.T., but we did cross the paths of several M.I.T.-affiliated folks. The delightful parents of **John McCafferty** were in our bus group. Paul Hajian, '80, went strolling past us in the Colosseum in Rome. And the gentleman with whom we struck up a conversation in a restaurant in Florence turned out to be the father of Carolyn Cook, '78. It seems the world is crawling with M.I.T. people.

Meanwhile, in Kathmandu: **Catherine McCammon** dropped me a postcard from there, where she was mountain-climbing. Catherine has been working on her Ph.D. in geophysics at the Australian National University in Canberra. She and Richard Howes had a mountain-climbing honeymoon in 1981 and 1982. She writes, "We have just finished an Australian mountaineering expedition to Kwangde (20,302 feet) in the Khumbu Himal, Nepal. Sadly, we failed in our summit bid at 20,000 feet due to a snowstorm. Afterwards, Richard and I went trekking to Everest Base Camp and back to Kathmandu. Great scenery. I hope to be in the U.S.A. next year on a post-doc." . . . **John Barr** is in the Army and stationed in Bavaria. . . . **Kamel Mukharesh** got his M.S. in construction engineering and management at Stanford, then went to work for ARAMCO in Dhahran, Saudi Arabia. He is currently a project engineer for a large offshore platforms construction program. He writes, "Work is very exciting and challenging." . . . Still living in London is **Beth Marcus.** . . . **P.N. Mikhalevsky** has been awarded the A.B. Wood Medal and Prize for 1983 from the Institute of Acoustics, United Kingdom, for "distinguished contributions to acoustics."

Carolyn Farley Maricq has just moved from Oxford to Providence, R.I., where she is trying to finish her thesis for a Master of Letters in management studies from Oxford. Husband Matti Maricq (Ph.D. from M.I.T. in chemistry, '79) is a new faculty member at Brown University. Watch for Carolyn at the 'Tute, where she hopes to appear sometime soon to use the libraries. . . . **Gerald Mata** is a "senior computer hack" for the Boston Edison Co. . . . **Brad Miller** moved to Rochester and is working for Computer Consoles, Inc., as a software engineer. He is also going to the University of Rochester part-time for a masters in computer science/artificial intelligence.

In January, **Karl Nyberg** joined a start-up high tech firm in McLean, Va., as the firm's third employee. Writes Karl, "We now have 12, and are going public this month. I'm also trying to buy a house and quit paying rent." . . . **Jeanne Brady** is "still a mechanical design engineer at Northrop Corp. I'm now a condo owner in the Boston area. Looking forward to hearing from other N.R.S.A. Buckaroos in the Boston area (hint, hint—I'm in the book, guys!)." . . . **Mark Sylvester** got his S.M. in January 1982 and "decided to leave M.I.T. (gasp! sob!) after I was offered obscene amounts of money by several companies. I now work for the Rogers Corp. as a senior development engineer in corporate research and development. I'm working in the area of very high performance polymers. This is a lot more fun than being a grad student. My wife, Lydia, and I are living in a 270-year-old house in Storrs, Conn., with our cats. It's nice, but very, very quiet, and the nearest good restaurant is a 45-minute drive away. I've read more books in five months than I did in the previous five years!"

Frank Fay married Nicole Provost in January, and they are now living in Seattle. They invite all their friends to come and visit them. . . . **Joseph Kulik** is a "full-time grad student and part-time radical political activist." . . . **Marvin Chartoff** is in "hot sunny Arizona with G.T.E. Microcircuits. This is the second of three assignments in G.T.E.'s marketing management training program. Will be moving on to third assignment in mid-August. Ran into Armand Tatevossian, '80, while back east on business.". . . **Michael Corradini** is an assistant professor in nuclear engineering at the University of Wisconsin. . . . **Douglas Barnard** has joined the

Chicago law firm of McDermott, Will and Emery.

Anne Michon and Scott Westbrook, '78, were married in July 1982 in Palo Alto, Calif. Attending the wedding were **Patrice Tyrell**, **Jason Arbeiter**, Larysa Kulynych, '80, Anitta Bliss, '78, Neal Sakima, '78, Wayne Wright, '78, John Babiak, '78, Ross Rappaport, '78, and Kevin Damon, '82. Anne is a project manager for Software Publishing Corp., and has designed and is currently developing a new product in the "pfs" series. . . . Another M.I.T. couple, **Brenda Hambleton** and **John Hopper**, just celebrated their fourth anniversary. John is a mechanical engineer for Northern Research and Engineering in Woburn. Brenda is assistant director of admissions for M.I.T. and has an office on the infinite corridor. Brenda writes, "I hope that anyone who comes to Boston will stop in to say hi. I'm going to Sloan in September for my masters but I will continue to work for the Admissions Office part-time. I hope to see everyone at our 5th reunion next year." Brenda and John own a house in Wilmington, just north of Boston. . . . **Juaquin Walling** has been working since graduation in the Nuclear Energy Systems Division at Lawrence Livermore National Laboratory in Livermore, Calif. He is presently project engineer for MX Electrical Systems in the Weapon Systems Group, handling electrical interfaces and design for a new warhead for the MX. "Taking TV courses at Stanford, and considering taking a leave of absence to come back to M.I.T. for an advanced degree in Artificial Intelligence." . . . **Barry Kulp** writes, "Lisa and I bought a house in Sutton, Mass., last November. It's nice to have so much space, so it's worth the longer commute. I'm working at Commterm in Burlington, doing hardware and software design with microprocessors (since January 1982). In the near future, I plan to start taking flying lessons—sailplanes and power planes, maybe even helicopters eventually!" . . . **Elliot Rossen** reports, "I'm going through a period of many changes. In June 1983, I graduate from Harvard Business School with an M.B.A., then three days later I'm getting married to a fabulous woman from Michigan. I start work August 1 in Chicago for the Marketing Department of the Quaker Oats Co. Everybody help me out and start eating lots of oatmeal! . . . A word from **Jeffrey Dugal**: "Just as my kayak and I mastered our offside roll last June, I was transferred from RD&E to Ball Corp.'s Plastics Division in Evansville, Ind. Ball is in the process of setting up a plastics packaging group to complement its glass and metal container offerings. Wish us luck. Hello to all my friends from Burton House and the rest of the 'Tute."

Michelle Prettyman is studying medicine at the Medical College of Virginia. . . . **Daniel Lu** just graduated from Pennsylvania State University Medical School and will be doing a pediatric residency at Stanford University.. . . **Ron Newman** is working on software for the Xerox "Star" professional workstation and "still immersing myself in the fascinating, multifaceted politics of the People's Republic of Santa Monica! After all those articles I wrote in *Thursday* and *The Tech*, the writer's bug has bit me again. I've written two articles this year in the *Free Venice Beachhead*, a local underground paper founded in 1968 and still going strong. My articles focus on the struggles of several elderly and disabled tenants to avoid eviction by their landlord, Rand Corp. I expect to write more articles on occasion when I can find the time.". . . The summer intern in finance here at Mobil this summer turned out to be **George Paganis**. George, who graduated with a degree in civil engineering, worked for a couple of years for Avco Corp., manufacturer of tactical weapons and missiles, as an energy conservation engineer in the systems division. In September 1982, he succumbed to the lure of the M.B.A. and started Cornell Business School, majoring in finance. He'll graduate in 1984. . . . Congratulations to **Esther Jaffe** and husband Jeff, '76, who presented little Jacob with a baby brother in May.

Is anyone interested in buying a copy of 1979 *Technique*? I have been informed that they are available for $14 plus $2.50 postage. Write to me if you want one, and I'll give you the details for ordering. Some news about yours truly. I have *finally* finished my two-year rotational program, and decided that two years in finance was enough for me. I'm now in telecommunications at Mobil, but still located in the same building. I'm not sure what my exact duties will be (neither do my bosses—they haven't figured out what to do with me yet!), but the people seem good and the field interesting, so I'm really excited about it. Besides, later this summer they're going to send me to Cincinnati for a two-week training course—what could be more exciting than that?—**Sharon Lowenheim**, Secretary, 131 E. 83 St., Apt. 2G, New York, NY 10028

81

Did you turn to this page first? If you enjoy reading about others, you can imagine how much everyone will enjoy reading about you! So drop me a quick note letting us all know how life's going for you these days.

After many wedding announcements, we've received our first baby announcements this month, which shows that our class is coming along nicely. **John** and **Meg Hayden** announce the birth of their first child, Brittany Leigh, born this past May 20 and weighing in at 8 pounds, 4 ounces. Meg writes, "In less than a week, she has taken control of our household and we wouldn't trade it for the world!" . . . Also a recent parent, **Guy Vachen** writes that he has "been timesharing between my wife, my baby daughter, Carolyn, and my thesis at C.I.P.G. studying the mixing behavior of inks. Still a Fellow of Bell Labs and recently selected Fellow of the National Hispanic Scholarship Fund."

Backing up a bit (so to speak) from births, our class has a few weddings to report. Lynn Garry, '82, and **John Salmon** were married this past May in the Berkeley Rose Garden. Past residents of Senior House were in full force, but rumor has it that only a few donned "Sport Death" t-shirts for the formal occasion. Guests included **Patrick Hamilton**, **Greg Aldisert**, Paul Hoffman, Kelly McGuire, Mike Wilson, Debbie Lerman, Dan Lieberman, Vickey Woolworth and former Burtonite **Lorenzo Sadum**.. . . **Jeffrey Green** married Barb Henderson a year ago August and is currently in New London, Conn., for submarine school. Jeff will be going to San Diego in December for duty aboard U.S.S. Flasher. . . . **Linda Laatsch** married David Carley and is working as a psychologist at Massachusetts Hospital School in Canton, Mass. . . . Finally in the wedding department, **Thomas Barta** would very much like to say that all rumors to the contrary; the reports of his recent marriage were greatly exaggerated. Oops—sorry, Tom.

I bet you folks are just dying to hear what's happening with your class officers. President **Lynn Radlauer**, currently working for Bain and Co., will be attending Harvard Business School this fall after travelling in Europe during August. . . . After a successful tenure at the Boston Office of Property Equalization, Treasurer **Walt Crosby** has left city government to found his own company, Property Technology, with two other partners. His firm will develop property tax software for cities across the United States. . . . Member-at-large **Steve Solnick** is still having a blast in Europe. Steve went to Russia for Christmas and to Israel and Egypt for Easter.

This month's corporate hotshot is **Jorge Herrera**, who has relocated to New York City after his recent graduation from Wharton. Jorge is in a one-year training program in the International Banking Group at the Park Avenue headquarters of Manufacturers Hanover. Jorge wants to thank all his friends who sent him congratulations at commencement, and wants to thank especially those who came to Philly to see the ceremonies.

After working for a year as a furniture maker, **James Oker** is living in Somerville and is now working with computer graphics. . . . **Thomas Misa** is continuing doctoral work in the Department of History and Sociology of Science, University of Pennsylvania. . . . **Therese Prisby** is an account manager for Network Consultants. . . . **Grant Harris** spent nine months helping his brother start a post-production business in New York City. Grant has applied to law school and is trying to get computer consulting work in western Massachusetts. . . . **Libby Guethlein** writes, "I'm still working in the wilds of Texas. Just got promoted to senior field engineer. I get up to Houston occasionally to visit **Valerie Vitale**." . . . **Marjorie Madsen** wrote to let us know she's having "wild and crazy times in Deutschland."

Before signing off, here's an offer to all members of our class: I'm now accepting volunteers to serve as one-time guest columnists. This is not an assistant secretary position. For one month, I'll send you all the stuff I get (and of course, you can add all the stuff you already know), and you get to write the column. Fun, huh? All the fame and glitter without that nagging long-term responsibility. So the glove has been dropped; write and take me up on my offer.—**Chuck Markham**, Secretary, 362 Commonwealth Ave., #2E, Boston, MA 02115

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Patty Cullen is studying Japanese at Berkeley to prepare for a year of work in Japan. By the time this column is printed, Patty will be living in Tokyo. She encourages any M.I.T. folks to contact her there (if you just happen to be in the area!). Her address is c/o Yutaka Kuwahara, 617-59 Yokokawa-cho, Hachioji-shi Tokyo 193 (phone 0426-26-2396). Patty's been living with Lisa Parachenian, '81, who is working on her Ph.D. Patty will be working on silicon molecular beam epitaxy for Hitachi Central Research Laboratory in Kokubunji. She presented her master's thesis at the 10th Annual Conference on Amorphous and Liquid Semiconductors in Tokyo in August. She hopes to go to China and India when she's done in Japan. Patty spent part of May backpacking in Baja, Calif., took a ferry to Los Mochis, Mexico, and hiked into the Barranca del Cobre (which is larger than the Grand Canyon) with a Tarahumara Indian guide. Patty also sends news of friends and classmates. She ran into John Pely, '81, who lived near her at Berkeley. She visited **Victor Quintana** in Phoenix, Ariz. She visited Oregon and decided it was the most beautiful state. (Patty seems to have gone everywhere or soon will!) Other M.I.T. folks going to Japan include **Tanya Sienko**, **Stephen Anderson**, **Steve Cohen**, **Bob McGreevy**, and **Helen Segal**.

Martin Carrera recently received three B.S. degrees (courses V, X, and XVIII, which are, respectively, chemistry, chemical engineering, and math). He's "looking forward to a new experience in graduate school" at the University of Chicago in physical chemistry. . . . **Douglas Stevens** writes that he is now at Albany Medical College and is looking forward to another graduation in 1986. . . . The former **Kathy Anderson** writes that she is now Kathy Lee, having married **Jeff Lee** last year. Kathy and Jeff are both doing graduate work at North Carolina State University in Raleigh, N.C., she in chemical engineering and he in microbiology. Kathy mentions that one advantage of North Carolina is the weather. She thinks of us in Boston every time she hears that it snowed. Kathy says she and Jeff hope to come visit (in the summer). . . . **Dan Metzger** spent the spring semester in Ames, Iowa, at Iowa State University. He was planning on getting a master's degree, but Beech Aircraft gave him an offer he couldn't refuse, and so he is now working for Beech in Andover, Kan., doing structural analysis work. In June, he and Eric Aslakson were groomsmen at the wedding of **Gerhard Straub** and Jeanne Swecker, '83.

That's the news this month. As for myself, I was sitting on Kresge Oval one fine day last summer and discovered the meaning of life. That was pretty exciting. (If you'd like to know, just write me news of what you're doing and I'll send you the answer.) I have yet to get up the courage to go hang gliding. My cat is good. And it looks like I'm going to be an actuary despite all the warnings from everyone I know that it's boring. Keep in touch.—**Rhonda Peck**, 38 Bigelow St., Cambridge, MA 02139

After two years in Washington as associate administrator of NASA's Office of Aeronautics and Space Technology, Professor Jack L. Kerrebrock is back as head of the Department of Aeronautics and Astronautics. In the picture he's welcomed home by Professor James W. Mar, '41, who was department head in Professor Kerrebrock's absence. (Photo: Calvin Campbell)

I

Civil Engineering

Next time you take the bus from an airport to Manhattan, think of **Mayer Horn,** S.M.'64; he's just been named vice-president of operations at Carey Transportation, Inc., New York City. . . . **Ricardo Dobry,** Sc.D.'71, an earthquake engineer who is professor of civil engineering at Rensselaer Polytechnic Institute, has been appointed to a three-year membership on the National Research Council's Committee on Seismology. . . . **Roger Foott,** Sc.D.'73, has been named manager of the San Francisco, Calif., office of Dames & Moore, responsible for the supervision of the firm's practice in the Bay Area and for cultivating overseas business development. . . . **Peter Likins,** S.M.'58, who was recently inaugurated last spring as president of Lehigh University, received an honorary Doctor of Law degree from Lafayette College at its 148th commencement.

Reginald A. Baron, S.M.'52, a retired civil engineer for the U.S. Army Corps of Engineers, passed away on February 12, 1983. He served the Corps for more than 34 years prior to retirement in 1972, most recently chief of the Soil Mechanics Division. During his career he was chairman of several national and international committees and author of many technical publications. . . . **Douglas C. Davis,** S.M.'37, a retired United States Air Force colonel from Ephrata, Wash., passed away on December 23, 1982; no details are available.

II

Mechanical Engineering

Professor **Ronald F. Probstein** is a member of the Advisory Panel to the Energy Engineering Board of the National Research Council's Commission on Engineering and Technical Systems.

The first $5,000 Edgerton Award for outstanding achievement in research, scholarship, and teaching at M.I.T. has been shared by **Warren P. Seering,** associate professor of mechanical engineering, whom the selection committee called "one of the leading young mechanical engineering faculty members in the country." His work is in mechanical design—the application of artificial intelligence to robotic manufacturing systems.

Charles R. Faulders, Sc.D.'50, reports that he is working in Canoga Park, Calif., at the Energy Technology Engineering Center, which is operated by Rockwell International for the Department of Energy. . . . **Foster B. Stulen,** Ph.D.'80, a member of Battelle Columbus Laboratories, Ohio, has been honored at Battelle's inventors' recognition banquet for receiving a 1982 patent for "a method that uses acoustics to separate dissolved gases from liquids." . . . **Edgar Rose,** S.M.'48, has been promoted from director of marine engineering to vice-president for marine engineering and research at Outboard Marine Corp., Waukegan, Ill.

III

Materials Science and Engineering

W. David Kingery, '48, professor of ceramics in the department, has been awarded honorary life membership in the American Ceramic Society. It's the society's highest honor and recognizes Professor Kingery's contributions through both teaching and research.

Professor **Nicholas J. Grant,** Sc.D.'44, is a member of the Energy Engineering Board of the National Research Council/National Academy of Sciences Commission on Engineering and Technical Systems.

Linn W. Hobbs, a leading electron microscopist of ceramic materials, has been promoted to full professor in the department. At M.I.T. for two years, Professor Hobbs studied at Northwestern and Oxford Universities, and he's chairman of the degree program in materials science.

Frederick S. Blackall IV, S.M.'75, has been named president of the Heat Treat Division of Taft-Pierce Manufacturing Co., Chicago, Ill., a manufacturer of production inspection equipment, surface grinders and super-finishing machines for government and industry. . . . **Pierre P. Turillon,** S.M.'56, has been appointed technical director, responsible for product development, research and customer technical support activities, at Alloy Technology International, Inc., Nyack, N.Y. . . . **Richard W. Hertzberg,** S.M.'61, New Jersey Zinc Professor of Metallurgy at Lehigh University, Bethlehem, Penn., is the recipient of a 1983 Eleanor and Joseph F. Libsch Faculty Research Award, given by the University "for oustanding achievement and distinction in research." His work has been in the field of fatigue in metals and polymers.

V

Chemistry

Walter H. Stockmayer, '35, who is Albert W. Smith Professor of Chemistry emeritus at Dartmouth, received an honorary doctorate of humane letters from Dartmouth on June 12. He taught chemistry at M.I.T. from 1937 to 1962, and Professor Stockmayer was honored by Dartmouth for his outstanding services as teacher and research scientist there since 1962.

Professor **F. Albert Cotton,** who was a member of the department at M.I.T. from 1955 until taking his present position at Texas A & M University, received the National Medal of Science from President Ronald Reagan in Washington on May 24. He was cited for his discovery of multiple metal-metal bonds and application of group theory to chemical problems.

Ajay K. Bose, Sc.D.'50, has been appointed the first George Meade Bond Professor of Chemistry at Stevens Institute of Technology, Hoboken, N.J. He is author of more than 180 research papers and two

books, and as a result of his contributions Stevens has become "a major center for research in the synthesis of penicillin and beta-lactam antibiotics." . . . **John E. Engelhart,** Ph.D.'61, reports that he has been promoted to director of cardiovascular drugs and planning management at Merck, Sharpe, and Dohme Research Laboratories, Rahway, N.J. . . . **Leighton B. Smith,** Ph.D.'19, retired head of the Chemistry Department at Tufts University where he was professor emeritus, passed away on April 16, 1983. From 1923 to 1929 he was a research associate in chemistry at M.I.T., later becoming assistant professor. He left M.I.T. to become assistant director of research and development at Lever Brothers, and then in 1952 joined the faculty at Tufts, retiring in 1961.

VI

Electrical Engineering and Computer Science

Professor **Fernando J. Corbato** is now acting associate head of the department for computer science and engineering; he succeeds Professor **Peter Elias,** '44, who's returned to full-time teaching and research. Until January 1983, Professor Corbato had been director of computing and telecommunication resources for M.I.T., a position now filled by Professor **James D. Bruce,** Sc.D.'64.

Herbert H. Woodson, '51, director of the Energy Center at the University of Texas, Austin, has been named head of the Energy Engineering Board of the National Research Council/National Academy of Sciences Commission on Engineering and Technical Systems.

Shikao Ikehara, '28, of Tokyo, Japan, is the author of *An Introduction to Information Theory–Information Science and M.I.T.*, published early this year by Keigatu Books, Tokyo.

The department's Analog Devices Career Development Professorship has been awarded to Professor **Charles G. Sodini,** who joined the faculty in January as asssistant professor; he succeeds **L. Rafael Reif,** promoted to the rank of associate professor during the summer. Professor Sodini's work is in the field of integrated circuits and systems; he was a member of the Hewlett-Packard Co.'s technical staff from 1974 until coming to the Institute, and his electrical engineering degrees are from Purdue and the University of California in Berkeley.

Bruce R. Musicus, Ph.D.'82, now holds the Class of 1956 Career Development Professorship; Professor Musicus joined the faculty to work on computer system architecture upon completing his Ph.D. last year.

Alan E.E. Rogers, Ph.D.'67, who's assistant director of the M.I.T. Haystack Observatory, has been honored by NASA—the Goddard Space Flight Center's outstanding service award for 1982 for his "outstanding contribution to very-long-baseline interferometry."

VIII

Physics

Five major changes in the department at M.I.T. announced during the summer:

☐ Professor **Jerome I. Friedman** has succeeded Professor **Herman Feshbach,** Ph.D.'42, as head of the department. Professor Friedman is an experimental particle physicist; from 1980 until now he's been director of the Laboratory for Nuclear Science. Professor Feshbach, head since 1973, will return to full-time teaching and research as Institute Professor.

☐ Professor **Arthur K. Kerman,** Ph.D.'53, will assume Professor Friedman's duties as director of the Laboratory for Nuclear Science.

☐ Professor **Jeffrey Goldstone** will succeed Dr. Kerman as director of the Center for Theoretical Physics.

☐ Professor **James D. Litster,** Ph.D.'65, is now di-

rector of the Center for Materials Science and Engineering, succeeding Professor **Mildred S. Dresselhaus.** Dr. Litster's field is phase transition and statistical mechanics, and he has been head of the Division of Condensed Matter, Atomic, and Plasma physics since 1979. A native of Canada, he holds the Gold Medal of the Association of Professional Engineers of Ontario and the Chancellor's Gold Medal at McMaster University, where he studied for his undergraduate degree in engineering physics.

□ Professor **Ernest J. Moniz,** known for his research on the interaction of pions with nuclei, is now director of the Bates Linear Accelerator; he succeeds Professor **Peter T. Demos,** Ph.D.'51, whose impending retirement was announced earlier. Dr. Moniz came to M.I.T. in 1973 with degrees from Boston College and Stanford.

Professor **Vera Kistiakowsky** is serving as Phi Beta Kappa visiting scholar for 1983-84; she will spend several days on each of six to eight campuses—typically smaller, liberal arts colleges—during the new academic year to lecture and visit with students about her interests and work.

Charles H. Townes, who was professor of physics and provost of the Institute from 1961 to 1966, received the Medal of Science from President Ronald Reagan in Washington on May 23. Townes, who is now professor of physics at the University of California in Berkeley, was cited for his studies of the interaction of matter with electromagnetic radiations.

Bradley Schaefer, a graduate student in physics at M.I.T., told the American Astronomical Society this spring that he's now correlated flashes of optical radiation with three gamma-ray bursts. He made the first correlation of optical and gamma radiation two years ago, and now two more have showed up in Schaefer's careful examination of photographs in the Harvard Observatory's collection, one made in 1901 and one in 1944. The optical energy release appears approximately the same in all three cases, and Schaefer says it's now clear that gamma-ray bursters flare up more than once in their lifetimes. But how it happens is by no means clear, he says.

XI

Urban Studies and Planning

Graeme Aylward, M.C.P.'66, a member of W.J. Cairns and Partners, Edinburgh, passed away on August 27, 1982. He was "at the zenith of his career and will be profoundly mourned by all those who were priviledged to have known him as a colleague, teacher, and friend," writes Mr. Cairns. Mr. Alywood had assumed the Chair of Architecture at Plymouth Polytechnic in January 1982, and he was "greatly acclaimed by this institution where students and faculty had already begun to appreciate the strength of his leadership, intellectual calibre and high ideals." Mr. Alywood began his architectural career as an outstanding designer in partnership with Derek Stow, London. In 1970 he joined the faculty of the School of Architecture and Building Science at the University of Strathclyde and then joined former M.I.T. colleagues in the Edinburgh practice of W.J. Cairns and Partners. Among many accomplishments he was a highly sought-after contributor at conferences and chairman of the Inter Architectural Schools Committee in Scotland.

XII

Earth, Atmospheric, and Planetary Sciences

It's official: **Irwin I. Shapiro,** who was Schlumberger Professor of Physics and Geophysics at M.I.T., is now Harvard's Paine Professor of Practical Astronomy, director of the Harvard College Observatory, and director of the Harvard-Smithsonian Center for Astrophysics; Professor Shapiro was on leave at Harvard last year. He was honored in June with the $5,000 Dannie Heineman Prize for Astrophysics of the American Institute of Physics and the American Astronomical Society, recognizing his "imaginative application of the techniques of radar and radio astronomy to the study of the solar system and to experimental tests of the general theory of relativity."

Enders A. Robinson, Ph.D.'54, was awarded honorary membership in the Society of Exploration Geophysicists at a special awards ceremony in Las Vegas on September 14, during SEG's annual meeting. He was cited as "father of convolution," in recognition of his seminal books and articles on signal processing. . . . **James Sprinkle,** '65, received the Charles Schuchert Award of the Paleontological Society on October 19, 1982, in recognition of his outstanding research on the morphology and taxonomy of Middle Paleozoic echinoderms. The award is reserved for young paleontologists who have achieved distinction in their research by age 25. James is now a professor in the Department of Geological Sciences at the University of Texas, Austin. . . . **Cyril J. Galvin,** Ph.D.'63, is coordinator of a short course on "Shorelines, Waterways, and Harbors," that will be held on October 26-27 at the Quality Inn, Pentagon City, 300 Army-Navy Dr., Arlington, Va. Cyril is presently a consulting engineer but was formerly chief, Coastal Process Branch (1970-1978) and oceanographer (1963-1970), U.S. Army Coastal Engineering Research Center, Washington, D.C.

William G. Johnston, Ph.D.'50, writes (from Regina, Saskatchewan) that he has been working for the Province of Saskatchewan for nearly 20 years, mapping the complicated Precambrian rocks of that province. . . . **William B. Farrington,** Ph.D.'53, visited Boston in early June and reported that he travels a great deal in connection with his work as a certified financial analyst, from his home in Laguna Beach, Calif.

John C. Hagen, Ph.D.'54, chief geologist for a Brazilian affiliate of Hanna Mining Co., Cleveland, Ohio, has been certified as a registered professional mining engineer in Brazil. . . . **David D. Jackson,** Ph.D.'69, reports, "I am still thriving after all these years in California. Wife (Kathleen Sloan, Wellesley 1969), daughter (Kelly age 8), and son (Morgan age 4) are hanging in there too. I am professor of geophysics at UCLA. I recently discovered that I have a not-so-rare form of anorexia nervosa, having run three marathons in less than one year. My family offers tremendous support in coping with this tragic condition."

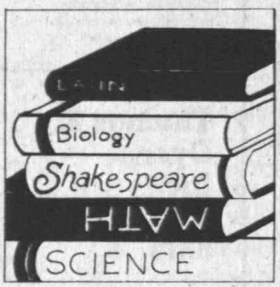
William E. Hammond, S.M.'40, former director of international activities for the industrial group of Combustion Engineering, Windsor, Conn., passed away on April 22, 1983. He became a registered New York State professional engineer in 1952 and was an active member of the American Society of Mechanical Engineers, American Society of Naval Engineers, and American Society of Naval Architects and Marine Engineers. He held 22 patents in Great Britain and the United States; chaired the International Technical Conference; and collaborated with the authors of *Modern Marine Engineers* and *Power Plants for Postwar Vessels*. Hammond joined Air Preheater Co. in 1947 and after 20 years was transferred to Hartford to take charge of the international activities of CE's Industrial Group. Following retirement in 1974, he was a licensing and engineering consultant on the international level.—Robert R. Shrock, Professor Emeritus, M.I.T., Room 54-926, Cambridge, MA 02139

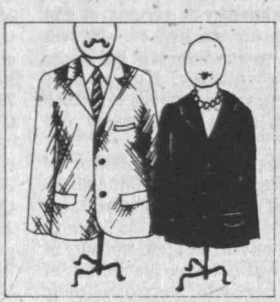
XIV

Economics

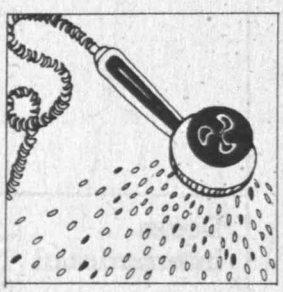
Professor **William D. Nordhaus,** Ph.D.'67, of Yale is coauthor (with Robert E. Litan of the Washington, D.C., law firm of Powell, Goldstein, Frazer, and Murphy) of *Reforming Federal Regulation* (Yale University Press, New Haven, 1983). Pointing out that regulatory structures have grown in the U.S.

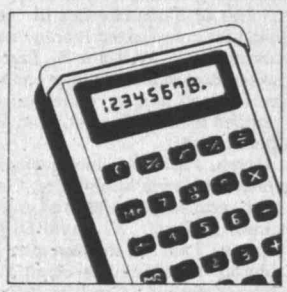
Things for reading, things for packing, things for speeding,

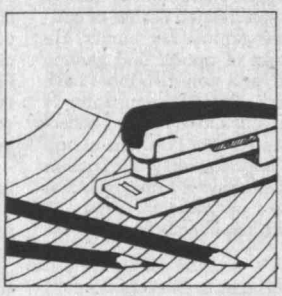




things for cracking. Things for playing, things for dressing,







things for spraying, things for guessing. Things for duty,

and things for soup, things for beauty at

the Coop

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special membership

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M.I.T. Student Center

without a mechanism for setting priorities or evaluating costs and benefits, the authors propose creation of a "regulatory budget" to provide oversight and reduce inefficiency. "An environment of greater political involvement," they say, would yield "more effective and balanced regulation."

Charles P. Kindleberger, professor of economics emeritus at M.I.T., will be president of the American Economic Association in 1985, serving as president-elect and chairman of its program committee for 1984. He was vice-president of AEA in 1966 and is a distinguished fellow of the association.

Shinichi Ichimura, Ph.D.'53, is presently involved in studies of Japanese and Southeast Asian economics. . . . **David Scheffman,** Ph.D.'71, reports, "I am returning to Washington, D.C., after a year in Montreal to take the position of deputy director for antitrust and competition at the Federal Trade Commission." . . . **Lowell W. Steele,** Ph.D.'52, an executive in the General Electric Co., has become director a of Walco National Corp., New York City.

William L. Eilers, S.M.'65, of Bethesda, Md., passed away on March 9, 1983; no details are available.

XV

Management

Professor **Eric von Hippel,** S.M.'68, is the author of "Increasing Innovators' Returns from Innovation," a chapter in the first volume (1983) of the annual publication, *Research on Technological Innovation, Management, and Policy* (Jai Press, Greenwich, Conn., $42.50). Professor Richard S. Rosenbloom of Harvard, editor, says von Hippel's paper offers "useful taxonomies of mechanisms that help innovators capture the benefits and distribute the costs of innovation."

Michael Phillips, S.M.'59, has been appointed corporate controller responsible for all accounting and cash management functions of William M. Mercer, Inc., an employee and compensation consulting firm, New York City. Formerly, he was vice-president and manager of budget and planning for Marsh & McLennan Companies, Inc. . . . **Paul H. Kalikstein,** '74, former group project manager of the Bayer line at Sterling Drug, Inc., New York City, has been named the firm's new products director, responsible for coordinating marketing efforts for new Glenbrook products. . . . **Donald Ravey,** S.M.'61, writes that he is coordinating graduate management alumni/ae activities in California's "silicon valley."

Jeremii W. Wesolowski, S.M.'64, writes that "after 17 years overseas with Squibb International, I returned to the U.S. My last post was that of managing director of Squibb, Portugal" . . . **John M. Greenwald,** S.M.'72, in 1982 began a new business, Micron Separations, Inc., manufacturing filtration products, of which he is president. . . . **Robert Schmitz,** S.M.'65, has been appointed vice-president book publishing and is a member of the management committee of Dow Jones, Inc. (since November 1982). In this capacity he was elected president and chief executive officer of Richard D. Irwin, Inc., a wholly owned subsidiary of Dow Jones. . . . **James H. Morris, Jr.,** Ph.D.'69, writes, "I am now director of the Information Technology Center at Carnegie Mellon University—the organization responsible for designing and implementing CMU's personal computer network."

Management and Technology Program

John A. Harrison, S.M.'83, is back at Bechtel Civil and Minerals, Inc., Washington, D.C., working on the Northeast Corridor Project. . . . **Julian N. Nikolchev,** S.M.'83, has settled in Menlo Park, Calif., where he has accepted a job with SRI as technology consultant in the Technology Management and Innovation Center. . . . **Wilbur (Bill) B. Vanderslice,** S.M.'83, has moved to a new home in Norwalk, Conn. He returned to IBM where he took a position at corporate headquarters as technical assistant to the director of development operations for the General Technology Division. . . . **Henry M. Montrey,** S.M.'82, has taken the additional role of acting director of the Wood Products Division at Weyerhauser.—Jane Morse, Program Manager, M.I.T., Room E52-533, Cambridge, MA 02139

XVI

Aeronautics and Astronautics

Fernando Sisto, Sc.D.'52, the George Meade Bond Professor of Mechanical Engineering at Stevens Institute of Technology, Hoboken, N.J., was honored last April as a "Distinguished Faculty Member" by the Institute. He headed the Institute's Department of Mechanical Engineering from 1969 to 1979 and holds the honorary master of engineering degree from Stevens Institute. "As both a professor and a researcher, he is respected for his high ability and seriousness of purpose," said the citation. . . . **G. Jeffrey Geier,** S.M.'69, is currently working at Aerospace Corp., El Segundo, Calif., on problems relating to satellite attitude control. He is living in Huntington Beach with his wife Anne and sons Ian (age 14) and Mark (age 7). . . . **Steven R. Maimon,** S.M.'65, has recently joined CACI, Inc., Washington, D.C., responsible for new business developments in U.S. and international markets. Areas include: customized computer systems and software design; integrated information management systems; business market and corporate development services; and new integrated security systems design and development services.

Julio A. Monjes, S.M.'72, is currently an optical systems engineer at the Lawrence Livermore Laboratory, Livermore, Calif., and is consulting on optical research and development. . . . **Paul S. Basile,** S.M.'72, writes, "I am currently general manager of IED Consultants S.A. in Geneva and head of corporate planning of the International Energy Development Corp. (IEDC). Geneva is a perfect place to live, work, ski, and generally enjoy oneself. Sloan background is, I find, very useful. My wife Gwen and children Mark (age 6) and Marie (age 3) fill most of the days with the International School of Geneva, studying French and English." . . . **Peter M. Bainum,** S.M.'60, was elected executive vice-president of the American Astronautical Society in October 1982. This past April, he was invited to lecture on the dynamics and control of large space structures at the 12th annual meeting of the African Group II of the INTELSAT Council of Governors in Bamako, Mali.

XIX

Meterology

Robert M. White, Sc.D.'49, an authority in the fields of meteorology and oceanography and first administrator of the National Oceanic and Atmospheric Administration, has been elected president of the National Academy of Engineering.

Eleanor M. Cramer, '45, passed away suddenly on May 9, 1983. Having received her B.A. degree from Mount Holyoke College in 1939, she came to M.I.T. as a WAVE in the U.S. Navy; no further details are available.

Technology and Policy Program

Win Hayward, S.M.'81, has a new position with the Strategic Planning Office of the Federal National Mortage Association, Washington, D.C. . . . **Elizabeth Mulcahy,** S.M.'79, has been appointed assistant dean for policy development at Case Western Reserve University School of Medicine. . . . **S.K. Sharma,** S.M.'78, has accepted a position with Tata Consulting Services, Poona, India.—Richard de Neufville, Chairman, Technology and Policy Program, M.I.T., Room 1-138, Cambridge, MA 02139

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was lower last year than Mr. Hartwell and his colleagues expected when dormitory rates were set, and the adjustment was in fact required under the housing contracts each dormitory resident signed a year ago. If costs had been higher than expected, students would have been tapped for an extra assessment.

Corporation Changes

Six new faces will be at the table when **David S. Saxon,** '41, himself new to the role of chairman, calls to order the fall meeting of the M.I.T. Corporation on October 7.

Five new members were chosen at the spring meeting on Commencement Day:

☐ **Robert A. Charpie,** president of Cabot Corp.

☐ **Herbert H. Dow,** '52, secretary of Dow Chemical Corp.

☐ **Joseph G. Gavin, Jr.,** '42, president of Grumman Corp.

☐ **Floyd H. Lyon,** '42, president and chairman of Halm Industries Co., Inc.

☐ **Rhonda E. Peck,** '82, the elected representative of recent classes to the Corporation.

Robert W. Mann, '50, Whitaker Professor of Biomedical Engineering in the M.I.T. Department of Mechanical Engineering, will also be present ex-officio as president of the M.I.T. Alumni Association.

In addition, **Mary Frances Wagley,** '47, executive director of Episcopal Social Ministries of the Diocese of Maryland, Inc., will rejoin the Corporation after a three-year absence, and **Howard W. Johnson** will take his place as a life member having resigned as chairman as of last July 1. He was named honorary chairman as well as life member last spring. In addition, **Ellmore C. Patterson,** retired president and chairman of Morgan Guaranty Trust Co., and **Edward O. Vetter,** '42, former executive vice-president of Texas Instruments, Inc., were advanced to life members.

Messrs. Dow, Gain, and Lyon were nominees to the Corporation by the Selection Committee of the M.I.T. Alumni Association.

A graduate of Carnegie Mellon, Dr. Charpie has been president of Cabot Corp. since 1969, when he came to Boston from Bell and Howell Corp. in Chicago. He began his career, following graduate study in physics, at Oak Ridge National Laboratory and later he was with Union Carbide Corp.

Mr. Dow joined Dow upon graduating from M.I.T. in chemical engineering, and he's been active in alumni, development, and visiting committee affairs at the Institute.

Mr. Gavin's M.I.T. degrees are in aeronautics, and he's a long-time member of that department's visiting committee. He joined Grumman in 1946 to direct development of the lunar module and later became president of Grumman Aerospace Corp.

Mr. Lyon's M.I.T. degree is in mechanical engineering, and he's been active since graduating in alumni and development affairs. He holds the Alumni Association's Bronze Beaver Award and earlier this year received the Marshall B. Dalton Award of the Corporation Development Committee.

Ms. Peck, who studied management at M.I.T., was a member of the Alumni Association staff working as director of telethons for the Alumni Fund following graduation. She is secretary of her class and holds a Karl Taylor Compton Award for contributions as an undergraduate.

Professor Mann has been long-time president of his class, a member of the Alumni Fund Board, and—most recently—vice-president of the Alumni Association.

W. Van Alan Clark, 1920-1983

W Van Alan Clark, Jr., S.M.'42, who was successively teacher and industrialist while throughout his life being an enthusiastic sailor and thoughtful philanthropist, died on July 16 in Boston after a long illness. He was 63.

Mr. Clark entered the Sloan School of Management after completing an undergraduate degree at Williams College in 1941. He returned after World War II Navy service to join the faculty and was for two years assistant dean. He then moved into high-technology industry by forming Sippican Corp. in 1958, of which he remained president until 1965 and thereafter was chairman until retirement in 1982. Meanwhile, he was active in developing other high-technology enterprises in New England.

After serving as a member of two visiting committees, Mr. Clark became a member of the M.I.T. Corporation in 1972 and was made a life member in 1982. He was a founding member of the M.I.T. Sustaining Fellows and was for 18 years prior to his death a member of the Corporation Development Committee, and in both roles he was a major supporter of M.I.T. fund-raising efforts. Meanwhile, he continued major contributions to his alma mater, William College, and the Woods Hole Oceanographic Institution. He was a world champion sailor in international competition.

But most of all his colleagues will remember Mr. Clark for his enthusiasm and liveliness. " . . . Very delightful to work with. . . a great sense of humor . . . very lively," recalled Dean Abraham J. Siegel of the Sloan School. " . . . a wise counsellor who profoundly advanced the Institute's stature as a center for management education," wrote David S. Saxon, '41, chairman of the Corporation.

Thornton W. Owen, 1904-1983

Thornton W. Owen, '21, a leader in business, civic, and charitable

Find This Beaver!

To the Editor:

No university has a more fitting mascot than M.I.T.'s beaver. And nature's engineer is immortalized in the strangest places—witness the photo.

I challenge fellow-alumni to keep an eye out for our furry friend, and to fuel the challenge I promise to donate $25 to the Alumni Fund in the name of the individual who sends in the earliest-postmarked letter identifying where this particular beaver makes his (her?) home. (If the response is enthusiastic, there are more beavers in hiding.)

Leigh J. Passman, '81
New York, N.Y.

The winner, the correct answer, and the winner's gift designation (unrestricted, scholarships, or residence funds) will be reported in a future issue.–Ed.

endeavors in Washington, D.C., and a major supporter of M.I.T., died on July 4 at his home in Rehoboth Beach, Md., following a heart attack. He was 79.

After 23 years as president of Thomas J. Owen and Son, Inc., real estate appraisers in Washington, Mr. Owen joined what is now the Perpetual American Federal Savings and Loan Association in 1966 to be its president, later becoming chairman of its board and finally in 1979 director emeritus. Meanwhile, he was an active supporter of M.I.T. through the Alumni Fund, the M.I.T. Club of Washington, and two major capital campaigns. He received the Alumni Association's Bronze Beaver in 1969.

Alexander Smakula, 1901-1983

Alexander Smakula, who came to the U.S. after World War II and to M.I.T. in 1951 and retired in 1966 as professor of crystal physics, emeritus, in the Department of Electrical Engineering and Computer Science, died on May 17; he was 82.

Soon after graduating from the University of Gottingen, Dr. Smakula had gained scientific attention for a method of determining electrons trapped in crystals by measuring optical absorption. Soon thereafter he also gained an international reputation for research on spectroscopic methods applied to organic compounds. Later, his findings on the link between the structural and optical properties of vitamins was vital in nutrition research.

Deceased

Arthur G. Weinz, '10; May 2, 1983; Lexington Hall, 178 Lowell St., Lexington, Mass.
Bartow V. Reeves, '12; September 1, 1982; 1027 Circle Dr., Palmerton, Penn.
Bernard W. Stevens, '12; April 10, 1983; Orleans Convalescent and Retirement Center, Orleans, Mass.
Stanley M. Lane, '17; May 28, 1983; PO Box 427, Bradford, N.H.
Harold C. Neumann, '17; March 13, 1983; 3663 Grand Ave,. Apt. 766, Des Moines, Iowa.
Everett F. Doten, '19; February 2, 1982; 2340 Kewanee Way, Okemos, Mich.
Lester Wolfe, '19; July 6, 1983; 870 United Nations Plaza, New York, N.Y.
Clayton C. Westland, '21; 1982; 50 Popham Rd. F2, Scarsdale, N.Y.
Thomas E. Shepard, '22; June 6, 1983; 470 Third St. So., No. 513, St. Petersburg, Fla.
Howard L. Cobb, '23; September 26, 1981; 250 Rockaway Ave., Boonton, N.J.
Donald W. Height, '23; June 5, 1983; 15 Curve St., Wellesley, Mass.
Oscar L. Perkins, '23; April 8, 1983; 66 Woodlawn St., West Hartford, Conn.
Ida B. Webster, '23; June 30, 1983; 32 East 64th St., New York, N.Y.
William Wolfe, '23; May 12, 1983; 18707 NE 14th Ave., Miami, Fla.
Laurence D. Bain, '24; June 5, 1983; c/o Mr. Laurence D. Bain, Jr., 69 Summit Ave., Brookline, Mass.
Reginald B. Miner, '24; May 26, 1983; 40 Concord Ct., Bedford, Mass.
Melvin C. Wagner, '24; May 8, 1983; 4 Wilcox Ln., Westport, Conn.
Robert Hodson, '25; May 16, 1982; 112 Bayswater St., East Boston, Mass.
Edward S. Johnston, '25; May 4, 1982; 1155 W. Fairway, Mesa, Ariz.
Thornton W. Owen, '26; July 4, 1983; 8101 Connecticut Av., Apt. N210, Chevy Chase, Md.
James B. Powers, '26; May 1982; 4915 S. Concord Ave., Great Neck, N.Y.
Stanley P. Sawyer, '26; June 5, 1983; 11 Robin Ln., Exeter, N.H.
David A. Shepard, '26; July 10, 1983; Creamer Hill Rd., Greenwich, Conn.
Charles E. Gewertz, '28; April 20, 1983; Hogbergsgatan 12, Vasterias, Sweden.
William A. Harris, '28; April 27, 1983; 49 Wallace Rd., Summit, N.J.
Sebastian B. Littauer, '30; February 2, 1983; Columbia University, Department of Industrial Engineering, New York, N.Y.
Edward J. Nolan, '30; February 1983; 387 Park Slope, Mountainside, N.J.
Henry T. Smith, '32; March 1, 1983; Old Groton Rd., Groton, Mass.
John H. Weber, '35; January 17, 1983; c/o R.O. Friedel, 13722 Hickory Nut Point, Midlothian, Va.
Lawrence Bernbaum, '40; June 7, 1983; 2350 Commonwealth Ave., Newton, Mass.
Robert P. Bunikis, '53; August 1, 1981; Old Falmouth Rd., West Barnstable, Mass.
Jesse R. Watt, '55; September 1982, Mount Vernon, Wash.
Richard A. Alden, '56; April 28, 1983; 3312-130 Caminito East Bluff, La Jolla, Calif.
Richard I. Teper, '56; May 12, 1983; 16844 Germain, Granada Hills, Calif.
Donald D. Van Winkle, Jr., '68, August 1977.
Mark M. Preissler, '76; May 21, 1983; 3 Chestnut St., Burlington, Mass.
William C. Franklin, '78; August 29, 1982; c/o William Fluck, 664 Pembrook Dr., Jenkintown, Penn.

Great Dome Associates

continued from page A9

Rowland E. Hill, Sr.
James F. Hoey, Jr.
Carroll G. Hornor
William H. Horton
James H. Johnson
Cyrus H. Kano
Seymour C. Kapsten
William R. Lacy
Charles J. Lawson, Jr.
Hung Liang
T. Kemp Maples
James O. McDonough
Hugh Parker
Hugh G. Pastoriza, Jr.
Robert S. Reebie
Robert L. Rorschach
Herbert L. Shivek
F. Curtis Smith
Morton F. Spears
D. Read Stevens, Jr.
William E. Strohmeyer
Franklin H. Swenson
Herbert G. Twaddle
William A. Verrochi
Hans G. Walz
Michael Witunski

1944
Martin Annis
Robert E. Benedict
L. C. Biedenharn, Jr.
Burton A. Bromfield
Robert M. Byrne
F. Scott Carpenter
Herbert L. Carpenter, Jr.
John Chamberlain
Andrew F. Corry
Lee C. Eagleton
John B. Gardner
Mary E. Guinan
Holton E. Harris
James F. Hield
Robert V. Horrigan
Warren H. Howard
William A. Jack
John H. Kellogg, Jr.
Martin King
Samuel H. Lamport
Jean-Claude C. Landau
W. Parlin Lillard, Jr.
Han Tang Liu
Richard A. Lopez
Kenneth W. Nelson
Robert S. Nobles
E. Alfred Picardi
William S. Richardson
Peter M. Rinaldo
Eugene A. Schnell
Joseph Shrier
Warren I. Signell
Leland F. Stanley
Caleb S. Taft
John T. Toland
Page S. Ufford, Jr.
James Woodburn
John Woolston
Aaron Zicherman

1945
William F. Blitzer
Christopher G. Boland, III
John J. Freiberge
Reynold A. Grammer, Jr.
Charles H. Hart, III
James B. Hoaglund
Sheridan C. F. Ing
Sing Leong
Andrew A. Marocchi
William G. Martin, Jr.
George E. McKewen, Jr.
William J. Meade, Jr.
Warren H. Miller
Nicholas V. S. Mumford, Jr.
David O. Richards
Max E. Ruehrmund, Jr.
Malcolm L. Schoenberg
Clinton H. Springer
Thomas I. Stephenson, III
Edward Stoltz, Jr.

1946
Richard M. Adler
Lyal D. Asay
Raymond E. Benenson
Ralph H. Berman
L. G. Body
Ernest U. Buckman
Charles E. Cloud
M. Louise Curley
Glen V. Dorflinger
Richard Dreselly
Charles J. Fisher
Alan R. Gruber
Theodore W. Henning
Ernest G. Jaworski
Mason I. Lappin
David R. Longmire
Robert H. Marks
A. William McEwan
Barbara R. Murray
William H. Schield, Jr.
Warren H. Turner

1947
Robert A. Aquadro
John E. Bartelt
Daniel V. Benade
Claude W. Brenner
Harold Brown
John A. Contegni
Robert N. Creek
Carl E. Eyman, Jr.
Wilfred L. Freyberger
Richard T. Gregg
Martin B. Judge
Arnold S. Judson
George J. Katz
Byron O. Lutman
Robert E. McBride
William J. McCurdy
Thomas McEvoy, Jr.
Leslie C. Merrill
James L. Phillips
Jack W. Rizika
Edwin A. Rosenberg
Martin D. Schwartz
Irving L. Schwarz
Carol Tucker Seward
Wm. Reid Smith-Vaniz, Jr.
Donald M. Van Greenby
Howard A. Zwemer

1948
Harold L. Abroms
Charles W. Adams
Eugene Ashley
William Bangser, Jr.
Jack A. Belz
Robert H. Bliss
Kenneth S. Brock
Thomas J. Cahill
Albert F. Carr
Cassius M. Clay
Richard J. Conlan
Robert Crane
Milton R. Daniels, Jr.
Robert W. Deutsch
Paul A. Erskine
Daniel J. Fink
George N. Fountas
Edward S. Frohling
Max E. Gellert
Curtis S. Green
Robert W. Hanpeter
John W. Hawkins
John C. Henderson
John E. Hill, Jr.
Robert O. Hirsch
William J. Joyce
J. Karl Justin
Irving Kagan
William E. Katz
Louis F. Kreek, Jr.
Norman H. Kreisman
John D. C. Little
William A. Lockwood
Adolf F. Monosson
Robert R. Mott
Thomas E. Pawel
John M. Randolph
Ralph I. Reis
Frederic M. Richards
Gilbert V. Rohleder
George E. Sherman
Mitchell Silverstein
Arnold M. Singer
Milton G. Slade
A. Graham Sterling, Jr.
Edward L. Stevens
Ellarson R. Stout
Donald F. Towse
John M. D. Walch
William Wallace, Jr.
Robert H. Welsh
Harvey B. Willard
William T. Wise
Robert A. Wofsey
Backman Wong
Theodore R. Yoos, Jr.

1949
Angelo R. Arena
Robert A. Arrison, Jr.
Marvin A. Asnes
Orlien N. Becker
Paul S. Bercow
James K. Berman
William A. Black
William R. Bohlman
Frederick I. Brown, Jr.
Norman A. Chrisman, Jr.
Leslie W. Cline, Jr.
Robert C. Cowen
Russell N. Cox
Ira Dyer
William S. Edgerly
John Fairfield, Jr.
Guilford W. Forbes
Donald L. Gillespie
Gerald J. Grott
David K. Hardin
Howard E. Hendershott, Jr.
Charles K. Holmes, Jr.
Charles W. Holzwarth
David R. Israel
Davis B. Keniston
John A. Knowlton, Jr.
Michael M. Koerner
Thomas J. Lamphier
Ray E. Larson
Saul Levine
Albert A. Levingston
Robert F. Mahar
Harold A. B. McInnes
John O. Merrill, Jr.
Donald R. Merriman
Paul G. Miller
Ford F. Miskell
Richard D. Morel
Oscar F. Noss, Jr.
George Piness, Jr.
Bernard J. Ruskin
Earl F. Smith
Nathal O. Sokal
Garland S. Sydnor, Jr.
Emilio J. Venegas
Charles M. Walker
E. Zapata H.

1950
David D. Adams
Lowell S. Bensky
Sterling G. Brisbin
Thomas C. Buchanan
Robert C. Carruthers
Cosimo L. Cataldi
Harry G. Foden
Richard A. Gnecco
Lawrence Gould
Malcolm Green
Charles F. Grice
Donald A. Harnsberger
Lawson P. Harris
Herbert L. Hochberg
Richard H. Holmberg
James A. Hooper
Robert D. Hutton
Carroll I. Johnson
John C. Kern
W. Oliver Kincannon, Jr.
Raymond A. Kretschmer
John B. Lawson
Gerald A. Lessells
Stanley Martin, Jr.
Jonas Medney
Raymond M. Moeller
Kent Moore
William Murphy, Jr.
Alfred M. Petrofsky
Harry F. Raab, Jr.
Henry C. Sharp, Jr.
Thomas E. Shepherd, Jr.
Myles S. Spector
John M. Swick
Stephen J. Toth
Constantine T. Tsitsera

1951
Raymond Atchley
W. Gerald Austen
Maria Azzarone Bentel
John H. Bergmann
Donald K. Crockett
Jules S. Davis
John F. Dennis
William R. Donahue
Charles W. Ellis
Allan Elston
Evan Evans
Robert S. Gooch
Richard T. Greenhill
Windsor H. Hunter
Gerald S. Ikelheimer
Morley D. Kahn
H. E. Knipmeyer
Frederick G. Lehmann
John C. Lowry
Robert G. Norton
James A. Pitcock
John S. Prigge, Jr.
David V. Ragone
William G. Rhoads
Bernard Rothzeid
Laurence L. Rubin
Samuel Rubinovitz
Arthur H. Schein
Clinton B. Seeley
Howard E. Simmons, Jr.
Paul G. Smith
Charles H. Spaulding
Theodore W. Stein
Frank H. Thomas, III
Frederick W. Weitz
John J. Welch, Jr.
Harry J. Zimmer

1952
Arthur I. Auer
Clyde N. Baker, Jr.
Jess L. Belser
C. William Carson
Bock M. Chin
Milton S. Dietz
Richard E. Heitman
Clifford H. Heselton, Jr.
Oscar W. Kaalstad
Harry S. Kradjian
Richard F. Lacey
Jack Larks
Robert M. Lurie
Paul A. Lux
Richard E. Lyle
Alex S. Malaspina
Nicholas Melissas
Kevork V. Nahabedian
Robert H Norton
Edward A. Ryan
Collin W. Scarborough, III
F. Garrett Shanklin
Stanley J. Solomon
T. Stephen Spacil
Donald F. Tarinelli
Sergio F. Valdes
Emil J. Volcheck, Jr.

1953
David M. Berg
E. Fred Brecher
Robert W. Chapman
Robert J. Gellert
Kent F. Hansen
Charles R. Johansson
Lionel L. Kinney
David L. Klepper
S. Eric Kondi
Douglas L. Meyer
Bernard H. Paiewonsky
Robert R. Piper
Jean-Pierre A. Radley
Burton M. Rothleder
Richard I. Singer
Willard B. Spring
Howard S. Stern
Maurice L. Torti, Jr.
Tollyn J. Twitchell
James A. Zurbrigen

1954
Gordon Aitken
Robert E. Anslow
Barbara A. Black
John Blair
Wallace P. Boquist
Frederick H. Bowis
Coleman Bresee
William J. Eccles
Peter Felsenthal
Camillo A. Ghiron
Charles H. Goodman
Thomas J. Henderson
Dean L. Jacoby
John C. Kiley
James E. Klapmeier
Samuel J. Losh
LeRoy G. Malouf
Aristides Miliotes
Raymond D. Mintz
John E. Preschlack
Joseph B. Scheller
Allen M. Schultz
George G. Schwenk
Marilyn Leader Shilkoff
David F. Springsteen
Harvey I. Steinberg
Robert W. Stewart, Jr.
Anthony Turano, Jr.
Robert D. Warshawer
Jerome D. Waye
David B. Whelpley
Kevin G. Woelflein
Klaus M. Zwilsky

1955
Richard I. Bergman
Bert V. Borngesser, III
Joseph G. Carleton
Pierre D. Casimir Lambert
Zaven A. Dadekian
Alan S. Dana, Jr.
Gilbert Davidson
James H. Eacker
Eduardo L. Elizondo
John M. Farmer
William Friedman, Jr.
Robert P. Greene
Michael E. Halpern
John F. Hayes
Charles C. Ladd
Warren H. Lattof
Roger D. Mackay
Gerald P. Maloney
Thomas A. Marlow, II
Sheldon H. Moll
F. R. Morgenthaler
William J. Neff
Richard D. Nordlof
Theodore G. Papastavros
Stuart S. Peltz
Edgar D. Pulsifer
Gregory L. Robillard
Randall S. Robinson
Walter Rubin
Bernard J. Sadoff, Jr.
Allan C. Schell
W. Chandler Stevens, Jr.
Francois C. Vigier
Ralph L. Wanger, Jr.
David S. Wilbourn

1956
George G. Alexandridis
Robert D. Alter
Walter Baturka
Howard S. Bertan
Bernardo Blaschitz
Bruce B. Bredehoft
Renato Cervantes
Ronald C. Clark
Kreon L. Cyros
William R. Dickson
Irwin Dorros
Frank Foster, III
Arthur Frank
Stuart Frank
Walter P. Frey
Samuel S. Friedman
Larry R. Goldberg
William S. Grinker
Richard A. Jacobs
David L. Kaufman
Haim Kennet
Robert L. Kissner
William M. Layson
William R. Leitch
Merlin E. Lickhalter
Richard I. Mateles
Robert B. Meeker
John A. Morefield, Jr.
John D. Mueller
Stephen F. Newman
William E. Northfield
Ira S. Polevoy
Jose M. Reyes
Bernhard W. Romberg
Axel E. Rosenblad
Jack L. Rosenfeld
Jesse A. Rothstein
Robert F. Santos
Gottfried T. Schappert
David S. Shefrin
Richard E. Skavdahl
John D. Stelling
Philip A. Trussell
Paul H. L. Walter
Thomas Yonker
Francis H. Zenie

1957
Paul R. Ammann
Richard L. Baird
Arthur E. Bergles
Bruce Blanchard
George H. Borrmann, Jr.
Alan S. Borstein
Edgar H. Bristol, II
Joseph J. Carty
John T. Christian
John A. Currie
William H. Doughty
Karl M. Duff
Lee H. Fister, Jr.
Robert Gal
Herbert M. Heller
Edward L. Hoyt
Patrick B. Hutchings, Jr.
Frederick L. Jaggi
Robert J. Jantzen
Eric G. Johnson, Jr.
Harry M. Johnson
Ronald W. Keefe
Richard M. Langendorf
Dorothy G. Levinson
Bernard S. Levy
Hugo Liepmann
Donald C. MacLellan
Terrence K. McMahon
Richard R. Monsen
Frederick L. Morefield
E. Alan Phillips
John Psarouthakis
John J. Rinde
Henry E. Salzhauer
Peter A. Samton
W. Selden Saunders
Herbert F. Schwartz
Harold P. Smith, Jr.

1958
William A. Bayer
Michael E. Brose
Paul L. Busch
Peter B. Carberry
Lewis H. Cohen
Stephen Corman
John F. Fallon, Jr.
Burton D. Figler
I. Howard Fine
Frank L. Galeener
Arthur S. Gelfand
Stephanos S. Hadjiyannis
William R. Hauke, Jr.
Alfred G. Hortmann
Richard H. Hough
John C. Ingraham
Robert D. Jones
McClaran Jordan
C. Rossiter Kuehner
Paul Z. Larson
Mary A. McLaughlin
Calvin J. Morse
Hugh J. Murphy
Robert E. Oleksiak
Cornelius Peterson
David J. Rachofsky
Robert M. Rose
Jaime R. Rosenthal
Paul H. Rothschild
Howard C. Salwen
Roy R. Scarpato
George H. Schade, Jr.
Louis B. Seigle
Joel A. Shulman
Matthew F. Smith
Mark W. Tenney
Vigdor L. Teplitz
Theodore J. Van Iderstine
Edward Wanger
H. Paul Zeiger
Arthur L. Zimmet

1959
Hayward R. Alker, Jr.
George L. Barnett
Bradford Bates
Emile A. Battat
John W. Brackett
James H. Brown
Allan S. Bufferd
Paul H. Ekberg
Jack M. Fischer
Norman A. Fujiyoshi
Martin F. King
Frank S. Koppelman
Dennis E. MacLain
Patrick J. McGovern, Jr.
Donald E. Murray
Adrian R. Reti
Philip M. Richardson, Jr.
Sheldon I. Rips
Paul G. Savage
Jerome Philip Schooler
Joseph P. Seidel
Oliver E. Seikel
Lynn R. Sykes
Irvin B. Van Horn
Stephen K. Whittemore
George N. Yerid

1960
Anthony Aldrich
William C. Blatchley
Terry F. Bower
Barry R. Bronfin
Charles R. Cushing
Thomas H. Farquhar
Standley H. Goodwin
Timothy P. Hart
Deena A. Koniver
George P. Koo
Thomas H. O'Connor, Jr.
Richard H. Oeler
Harold J. Parmelee
Erik T. Ringkjob
M. Elizabeth Schumacker
Susan E. Schur
Alan B. Shalleck
Patrick S. Spangler
Frank A. Tapparo
Tom N. Thiele
Robert S. Troth
Victor A. Utgoff

1961
John W. Baxter
Andrew Buffington
Leo J. Cannon
Roy A. Chin
W. Mills Dyer, Jr.
Reed H. Freeman
Thomas L. Geers
Jerome Goldstein
Peter R. Gray
William C. Grimmell
William J. Hecht
Lawrence A. Horowitz
Maynard R. Johnson
William E. Jouris
Wilson D. Kendall
William B. Lenoir
Richard A. Mezger
Richard F. Otte
Gerald E. Pollon
William M. Richardson
Homer D. Schaaf
Edward H. Sonn
William Strauss
Craig S. Tedmon, Jr.
Thomas W. Traylor
Michael S. Walker
Stephen R. Waltman
Gerald L. Wilson

1962
Robert E. Anderson
Thomas G. Burns
Vito A. Caravito
Arthur Roger Cooke
Donald M. Dible
Edward A. Feustel
Albert F. Gleim
Jeremy R. Goldberg
Robert L. Goldsmith
Robert H. Heinmiller, Jr.
Terry J. Kohler
Theodore P. Labuza
Robert F. Morse
Philip H. Nelson
Darold W. Rorabacher
Arthur J. Samberg
Judith E. Selvidge
Thomas P. Sheahen

1963
Edwin F. Brush, Jr.
James A. Champy
Frederick E. Cunningham
Douglas E. Dancis
James Stark Draper
Thomas A. Goddard
Tomas Goldberger E.
Richard V. Goodman
J. Michael Greata
Milton J. Grebler
Stephen P. Kaufman
Maurice H. Lanman, III
Robert M. Levin
Robert P. Porter
Russell E. Prins
Robert H. Rabiner

Alan O. Ramo
Michael J. Schaffer
Joel E. Schindall
Charles C. Schumacher
Peter T. Van Aken
Grant M. Wilson

1964
F. Michael Armstrong
Wayne F. B'Rells
Leslie M. Boring, Jr.
Richard A. Carpenter
Leonard Chess
Ernest M. Cohen
Ronald H. Cordover
John P. Downie
Michael B. Godfrey
John N. Hanson
Lester L. Hendrickson
Roger L. Hybels
Mark Joseph
Leon M. Kaatz
Brian R. Kashiwagi
Joseph F. Kasper, Jr.
Joseph L. Kirk
Glenn A. Larson
Donald S. Levy
Stephen B. Miller
Alton B. Otis, Jr.
Peter J. Sherwood
Jay M. Tenenbaum
Thomas C. Vicary

1965
Arnold R. Abrams
William R. Brody
Edward A. Bucher
Arthur A. Bushkin
W. David Carrier, III
L. Scot Duncan
Howard M. Ellis
Peter G. Gerstberger
John J. Golden, Jr.
George L. Hadley
Dawn Friedell Jacobs
William N. Kavesh
Louis A. Kleiman
Peter A. Klock
Alan C. Leslie
Steven B. Lipner
John A. Ottesen
Robert B. Reichelt
John D. C. Roach
Emile Sabga
Gregory L. Schaffer
Donald L. Shulman
Robert L. Silverstein
Douglas C. Spreng
Richard L. St. Peters
G. Wayne Thurman
Carol E. Van Aken
Michael G. Weiss
Ronald Wilensky
Stephen L. Williams
David L. Yuille

1966
Michael R. Adler
Arthur N. Boyars
Richard R. Brady
Paul A. Branstad
William L. Bunce
Richard Y. Chung
Richard T. Cockerill
Peter M. Cukor
Ralph M. Davison
Steven H. Disman
Logan L. Donnel
Bert E. Forbes
Victor K. Fung
Philip M. Jacobs
Michael D. Kinkead
Robert D. Large
Gerald F. Madea
Harry C. Moser
Henry H. Perritt, Jr.
Ralph G. Schmitt
Joseph I. Smullin
Joseph W. Sullivan, Jr.
Frank E. Surma, Jr.
William R. Tippett, II
John Torode

1967
John Acevedo
Donald A. Belfer
James W. Carter
William L. Caton, III
W. Thomas Compton
John M. Davis
David A. Dilling
Carl B. Doughty
Alan B. Hayes
Lutz P. A. Henckels
Edson C. Hendricks
Arthur C. Kwok
William E. Murray, Jr.
John S. Podolsky
John C. H. Reykjalin
Chet Sandberg
John M. Shufelt
Joel M. Steinberg
Arthur S. Warshaw

1968
Harvey Allen
Platte T. Amstutz, III
Paul F. Bente, III
William E. Carlson
Samuel A. Cohen
Claude L. Gerstle
Paul A. Gluck
Daniel M. Green
Peter Groot
John P. Linderman
Scott P. Marks, Jr.
Juan M. Meyer
Charles B. Miller, Jr.
Kenneth P. Morse
William M. Parks
Joel P. Robinson
Leonard H. Schrank
Jonathan D. Shane
Michael Weinreich

1969
Dariush Ashrafi
Melvyn P. Basan
William P. Bengen
Robert A. Berntson
Denis A. Bovin
Marc Davis
Bruce R. Donath
Paul D. Evans
Matthew M. Franckiewicz
Anthony George
Andrew C. Goldstein
Bruce L. Heflinger
Kenneth R. Horner
Joseph A. Horton
Bernard E. Klein
Aaron Kleiner
Alan K. Kudler
Carl W. Kuhnen, Jr.
Michael W. Laird
Samuel E. Polanco
R. Frank Quick, Jr.
Franklin P. Rogers
Christopher R. Ryan
Michael Sporer
Michael P. Timko
James P. Truitt, Jr.
Hal R. Varian
Hing Y. Watt

1970
Gregory K. Arenson
Karen Arenson
David S. Bann
Wendell C. Brase
Gerald L. Brodsky
James C. Bronfenbrenner
James L. Caldwell
Daniel R. Cherry
Eric K. Clemons
Stephen F. Cooper
Harry D. Feldman
Linda L. Furrow
Robert F. Gonsett
John C. Head III
C. Gordon Hunter
Richard W. Ihrie
William C. Michels
William B. Parsons
David T. Patten
Anthony C. Picardi
Christopher L. Reedy
James B. Rothnie, Jr.
Stephen R. Takeuchi
Walter Yorsz

1971
Richard A. Aparo
R. A. Castro Alpizar
Thomas C. Kelly
Robert D. Marshall, Jr.
Robert N. Schulte
Laurence Storch
Charles W. Werner
Philip R. Widing

1972
Bradley C. Billetdeaux
John M. Bissell
Jack E. Cater
Leonidas P. Colakis
David A. Davis
Marshall B. Goldman
G. Paul Hendrickson, Jr.
Donald H. Layton
Hampton Pitts
James W. Roxlo
Gary J. Schuitema
Hikaru P. Shimura
John W. Taylor
Robert E. Zahler

1973
John R. Bertschy
John R. Gersh
Debra Judelson
Samer S. Khanachet
Patrick A. Marcotte
Stephen P. Miller
C. Timothy Ryan
Philip M. Sadler
J. Alexander Stevens
Cynthia Day Stratton
John W. Vander Meer, III

1974
James Richard Andrew
Charles Shadell Bruno
Ian Fisher
Roderick John Holland, Jr.
Niels Eric Mortensen
John Emery Plum
Gary David Raymond
Frank M. Sauk
Jay W. Van Dwingelen

1975
Harold M. Cook
Charles Fendrock
Henry G. Heck
David K. Hudson
Paul D. Husby
Mark A. Lysne
Robert W. Mann, Jr.
Richard J. McCarthy

1976
Janis Bestul Ossmann
Jeslie R. Chermak
Garret A. Davies
Jeffrey J. Held
Kelly P. McClellan
Juzer S. Mogri
George W. Todd, IV
James P. Wajda
Robert J. Winkler

1977
Paul J. Ackman
Charles B. Baltimore
Danny Bigio W.
Earl H. Bunker
Walter H. Goodwin
Brian G. R. Hughes
Charles G. Mogged, Jr.
Timothy F. Morison
Michael W. Sonnenfeldt
G. Scott Thompson

1978
Peter C. Coffee
Susan L. Kayton
Tapio L. Kuusinen
Barbara K. Ostrom

1979
Anne M. Michon

1980
Timothy M. Folster
Peter J. Francis

1981
Stuart L. Anderson
Thomas P. Garigan
William I. Ogilvie

1982
Robert D. Powell

Aeronautics and Astronautics
Carl Alexoff '56
Daniel H. Daley '46
Carlo N. De Gennaro '53
David W. Dove '71
James W. Harrill '64
Richard D. Linnell '48
John A. Long '33
Howard A. Magrath '38
James S. McDonnell, III '59
James S. Miller '61
Theodore H. H. Pian '48
John G. Ryan '60
George S. Schairer '35
Leroy P. Smith '49
A. Tobey Yu '46

Architecture
Frederick R. Bentel '50
Bill C. Booziotis '60
Thomas D. Cabot, III '82
C. Rosalie C. Carson '47
Robert P. Cooke '62
Yusing Y. S. Jung '62
Toufic E. Kadri '82
John W. Peirce '47
Ewart A. Wetherill '58

Biology
David Baltimore '61
Russell Kuo-Fu Chan '74
Barry J. Fry '70
David A. Gubbins '81
Peter N. Rosenthal '68
Robert H. Rubman '71
Trent S. Russell '42
Alfred M. Webb '47
Barbara A. Wolf '73

Chemical Engineering
Benson U. C. Aghazu '72
Leonard Berkowitz '58
P. L. Thibaut Brian '56
James S. Bruce '39
Bernard Chertow '48
Jerry A. Cogan '32
John P. Cogan '32
Robert H. Cotton '39
Andre C. DePrez '55
John E. Fay, II '71
Joel H. Friedman '80
Maurice F. Granville '39
Robert L. Greene '47
Hugh Robert James '74
George R. Jasny '52
Earp F. Jennings, Jr. '39
James R. Katzer '70
Ernest I. Korchak '61
James Lago '47
Edward A. Mason '50
Jerry McAfee '40
John E. Millard '35
Marion Monet '43
Tim Montgomery '74
Edward W. S. Nicholson '36
John H. O'Neill, Jr. '51
R. Robert Paxton '49
Donald W. Peaceman '51
William A. Reed '43
Robert L. Richards, Jr. '51
Keith E. Rumbel '70
Leonard W. Russum '47
George F. Schlaudecker '39
John P. Schmidt '63
Hugh W. Schwarz '42
Ronald A. Shulman '57
Robert E. Siegfried '47
Robert S. Smith '47
Herbert L. Stone '53
William E. Tucker, Jr. '42
Cheng C. Wang '46
Douglass J. Warner '59
James C. Wei '54
Martin A. Welt '57
Jack C. Williams '38
Kwang J. Won '79
Irwin S. Zonis '52

Chemistry
Fred A. Bickford '33
James J. Bishop '69
Clifton J. Blankley '67
Carl H. Brubaker, Jr. '52
Howard S. Corey, Jr. '55
Hugh L. Dryden, Jr. '50
Lionel S. Galstaun '34
Harbo Peter Jensen '74
Andrew V. Nowak '72
Janet Sanford Perkins '52
Emily L. Wick '51

Civil Engineering
Thomas W. Anderson '37
Albert H. Bryan, Jr. '48
Shelby H. Curlee '60
Kenneth C. Deemer '52
David D. Driscoll '69
M. David Egan '66
Thomas F. Gilbane, Jr. '75
Charles W. Johnson '55
Thomas D. Landale '54
Shih Y. Lee '43
Frederick G. Lehman '39
William O. Lynch '47
Thomas S. Maddock '51
William A. Moylan '80
John F. O'Leary '66
Kwan D. Park '55
Arthur C. Ruge '33
Elie A. Sehnaoui '61
William C. Stookey '51
Richard A. Sullivan '59
George P. Turci '56
Charles R. Walker '48
Stanley M. White '76
Roger H. Wingate '37

Earth and Planetary Sciences
Nicholas G. Dumbros '34
Louise H. Herrington '41

Economics
Robert W. Adams '51
Leslie Cookenboo '53
Vincent A. Fulmer '53
Thomas G. Hall '52
J. Wade Miller '48

Electrical Engineering
Arthur H. Ballard '50
David R. Bieberle '78
Richard W. Boberg '73
Anthony P. Di Vincenzo '47
Jay W. Forrester '45
Hans P. Geering '71
Robert F. Hossley '73
Stephen J. Jatras '52
Alexander Kusko '44
Jean D. Lebel '53
Gordon M. Lee '44
Henry S. Magnuski '73
Robert L. Massard '50
Terrence P. McGarty, Jr. '71
Charles W. Merriam, III '55
John Richard Mulhern '70
Cedric F. O'Donnell '51
Robert A. Price '53
Alexander L. Pugh, III '53
James R. Relyea '58
William M. Snyder, Jr. '39
John R. Whitford '49

Management
George A. Bobelis '58
Roy O. Brady, Jr. '72
Ralph N. Bussard '69
Vincent S. Castellano '77
Robert V. Clapp '63
William L. Clifton, Jr. '70
John F. Fort, III '66
Donald V. Fowke '63
Maurice A. Garr, Jr. '49
Kenneth F. Gordon '60
Donald M. Hague '77
Frederick L. Hall '67
Winston R. Hindle, Jr. '54
Jack Hubbard '63
Thomas G. Ioerger '75
Stephen A. Landon '68
James B. Law '52
Paul H. Levy '77
John Norris Maguire '60
Robert Y. Mao '72
Karen Mathiasen '71
Bruce A. H. McFadden '75
Robert Barry Moser '74
Donald H. Peters '69
John D. Proctor '73
Arnold O. Putnam '47
Thomas J. Quinlan '81
Richard G. Schweikhardt '73
Arthur J. Seiler '32
Lee L. Selwyn '69
Denis M. Slavich '71
William E. Small '69
Dan S. Somekh '67
James A. F. Stoner '61
Allen N. Strand '64
Susan K. Sudman '75
Yaron D. Teplow '62
Martin Trust '58
Thomas R. Williams '54
Zenon S. Zannetos '55

Materials Science and Engineering
J. Howard Beck '35
F. William Bloecher '49
John A. Fellows '32
George E. Nereo '63
Robert C. Ruhl '67
Reinhardt Schuhmann, Jr. '38
Howard R. Spendelow, Jr. '42
Janine J. Weins '70

Mathematics
Alan E. Berger '72
David A. Castanon '76
Robert A. Clark '49
John H. Doles, III '69
Andrew M. Odlyzko '75
Janice R. Rossbach '51
Robert E. Sacks '75
Claude E. Shannon '40
Norton Starr '64

Mechanical Engineering
Anthony E. Alonzo '58
John C. Chato '60
Robert H. Davis '50
Charles N. Griffiths '37
Helge K. Heen '55
George E. Keeler '54
George A. Lavoie '70
Roger L. McCarthy '77
Marlen L. Miller '54
Watson E. Slabaugh '30
Jan A. Veltrop '53
Chiao J. Wang '46

Meteorology
James R. Mahoney '66
Leonard W. Weis '47

Naval Construction and Engineering
Norman K. Berge '60
Charles A. Curtze '38
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Henry E. Fish '61
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Leonard W. Golden '55
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Donald A. Henriksen '68
Takashi Iwamura '78
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Shirley M. Picardi '81
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R. Dewey Rinehart '56
Barry Rosenberg '67
J. Phillip Samper '73
Robert E. Scifres '50
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Honorary
Roy Lamson
James N. Phinney

Puzzle Corner/Allan J. Gottlieb

Allan J. Gottlieb, '67, is associate research professor at the Courant Institute of Mathematical Sciences of New York University; he studied mathematics at M.I.T. and Brandeis. Send problems, solutions, and comments to him at the Courant Institute, New York University, 251 Mercer St., New York, N.Y. 10012.

Fannie Dooley Will Gefozzle You

Since this is the first issue of a new academic year, we once again review the ground rules for "Puzzle Corner":

In each issue we present five regular problems (the first of which is chess- or bridge-related) and two "speed" problems. Readers are invited to submit solutions to the regular problems, and three issues later one submitted solution is printed for each problem; we also list other readers whose solutions were successful. In particular, solutions to the problems you see below will appear in the February/March issue. Since I must submit that column sometime in November (today is July 20), you should send your solutions to me during the next few weeks. Late solutions, as well as comments on published solutions, are acknowledged in the section "Better Late Than Never" in subsequent issues.

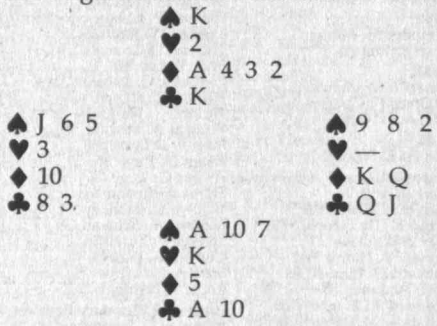
For "speed" problems the procedure is quite different. Often whimsical, these problems should not be taken too seriously. If the proposer submits a solution with the problem, that solution appears at the end of the same column in which the problem is published. For example, solutions to this issue's "speed" problems are given below. Only rarely are comments on "speed" problems published or acknowledged.

There is also an annual problem, published in the first issue of each new year; and sometimes we go back into history to republish problems which remained unsolved after their first appearance.

All problems come from readers, and all readers are invited to submit their favorites. I'll report on the size of the backlog, and on the criteria used in selecting problems for publication, in a future issue.

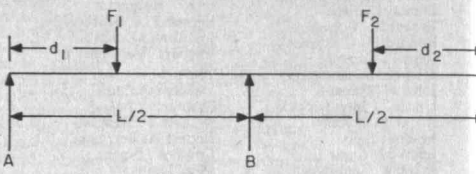
Problems

OCT 1. We begin with a seven-card bridge problem from Emmet Duffy. South is on lead and is to take all seven tricks against the best defense:



OCT 2. The next (presumably serious) offering is from Robert Pease:
But of course, Fannie Dooley loves to Baffle people. And Gefozzle them, too. You see, Fannie loves vanilla, but not chocolate. She loves Allan J. Gottlieb but not Robert Pease. She likes doors but not windows. She likes Mississippi, but not Alabama, California, or New York. . . . Also, she loves Arrowroot cookies . . . but doesn't care for tapioca. I told a couple of my friends, Lenna Mooree and William Llewellyn, and *they* figured it out. Fannie also loves the Massachusetts Institute of Technology and Harvard College, but not Princeton University . . . she likes cherry-wood furniture but not mahogany. Now do you see why? It's a fun game for people of 5th-grade mentality . . . Of course, you have figured this out, but if you can't figure out why Fannie Dooley prefers all this hoop-la, to plain ordinary BLAH, ask a VOODOO doctor.

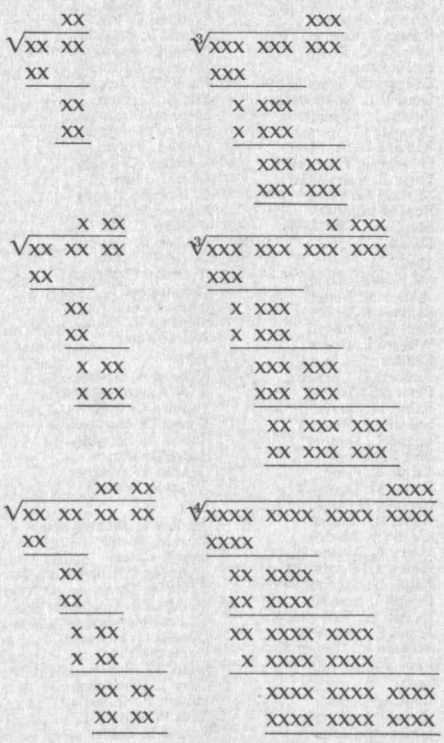
OCT 3. Benjamin Madero proposes a variation on **1982 N/D 3**; by writing "I think a more interesting problem would result if the loads and reactions on the beam were inverted, that is, two concentrated loads and three reactions." Then the problem would be:
A massless beam of length L is supported by three stanchions A, B, and C at the ends and midpoint. The beam is loaded with point loads F_1 and F_2 at distances d_1 and d_2 from the ends. What is the downward force on each stanchion?



OCT 4. Greg Schaffer wants you to show that for all $N \geq 3$

$$\sum_{k=0}^{N-1} \cos\left(\frac{4\pi k}{N}\right) = 0$$

OCT 5. John Woolson proposes six root extraction problems (the last of which he claims is not for the faint of heart). In all the problems each x is to be replaced with a digit (duplicates permitted), the numbers are base 10, no leading zeros are allowed, and no zeros are allowed in the roots themselves.



Speed Department

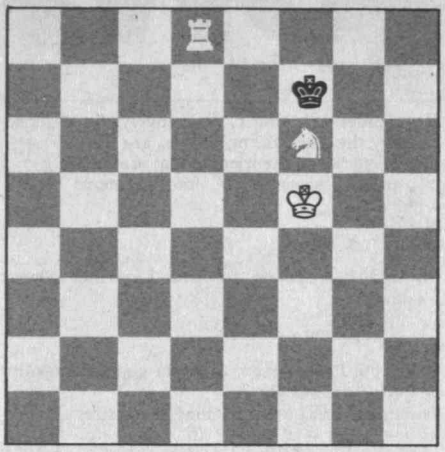
OCT SD1. Smith D. Turner (also known as $\int dt$) asks what the following three numbers have in common:

1. 371 288 574 2 . . .
237. 581 208 759 3 . . .
3550. 260 181 586 5 . . .

OCT SD2. C. Baker has 5-, 11-, and 13-pint jugs, all empty, and a full 24-pint jug. How does he divide the liquid into three equal portions?

Solutions

M/J 1. White to move and mate in four.



Elliot Roberts sent us the following solution:

1. N-g8 . . . K-g7	
2. N-h6 . . . if K-h7	2. . . . if KxN
3. K-f6 . . . KxN	3. R-d7 . . . K-h5
4. R-h8 mate	4. R-h8 mate

Also solved by Edward Gaillard, Richard Hess, Peter Hagelstein, Everett Leroy, Ronald Raines, David Evans, Matthew Fountain, and the proposer, John Cronin.

M/J 2. Find a nontrivial, continuous, real-valued function f(x) possessing continuous derivatives of all orders and satisfying the infinite-order differential equation:

$f = f' + 4f'' + 9f''' + 16f'''' + \ldots$

Paul Schweitzer writes:

A solution is

$f(x) = Ae^{ax}$ (1)

where A is real and arbitrary, and where a is a real zero of the polynomial $g(x) \equiv 1 - 4x + 2x^2 - x^3$, lying between -1 and 1. To see this, substitute (1) into the differential equation

$0 = -f + Df + 4D^2f + 9D^3f + 16D^4f + \ldots$ (2)

to get

$$0 = Ae^{ax}\left[1 - \sum_{n=1}^{\infty} n^2 a^n\right]$$

(sum convergent for $|a| < 1$)

$$= Ae^{ax}\left[1 - \frac{a(1+a)}{(1-a)^3}\right]$$

$$= \frac{Ae^{ax}}{(1-a)^3}\, g(a).$$

Consistent if g(a) = 0. Since g(.25) = 7/64 > 0 and g(.3) = −.047 < 0, a lies between .25 and .3. Also, since $dg(x)/dx = 4(x-1) - 3x^2$ is ≤ 0 for $x \leq 1$, this is the only real choice of a: inside [−1, 1] with g(a) = 0.

Also solved by Henry Lieberman, Leo Harten, Charles Sutton, John Prussing, Jerry Grossman, Stephen Persek, Richard Askey, Matthew Fountain, Peter Hagelstein, Richard Hess, and the proposer, Frank Rubin.

M/J 3. Two cryptarithmetic puzzles:

$$\frac{\text{EVER}}{\text{NNNNN}} = .\text{ONANDONANDON} \ldots$$

$$\frac{\text{EVER}}{\text{VVVVV}} = .\text{ONANDONANDON} \ldots$$

$$= \frac{\text{IRIS}}{\text{IIII}}$$

Robert Way found 7678/33333 as a solution to the first part and proved the second has no solution. The proposer offers 3638/66666 but does not com-

I	II	III
$m_a^2 = h_a^2 + \left(\frac{a}{2} - x\right)^2$	$x^2 = b^2 - h_b^2$	$(a-x)^2 = c^2 - h_a^2$
$m_b^2 = h_b^2 + \left(\frac{b}{2} - y\right)^2$	$y^2 = c^2 - h_b^2$	$(b-y)^2 = a^2 - h_b^2$
$m_c^2 = h_c^2 + \left(\frac{c}{2} - z\right)^2$	$z^2 = a^2 - h_c^2$	$(c-z)^2 = b^2 - h_c^2$

ment on IRIS/IIIII. Perhaps I have misinterpreted the problem.

Also solved by Richard Hess, Naomi Markovitz, and Matthew Fountain.

M/J 4. Find three consecutive three-digit prime numbers x, y, z, such that $z - y = y - x = 12$. In other words, there are no prime numbers between x and z, other than y. Find four consecutive three-digit prime numbers a, b, c, d, such that $d - c = c - b = b - a = 6$. What is the largest string of consecutive primes $P_1, P_2, \ldots, P_n$ such that: $P_n - P_{n-1} = P_{n-1} - P_{n-2} = \ldots = P_2 - P_1 = 4$.

Charles Sutton writes:

I found this problem particularly interesting, since the basic idea involved, consecutive primes in arithmetic progression, can be considered a generalization of the well-known twin prime problem. One would expect the distribution of pairs of primes differing by 4 to be similar to the distribution of the twin pairs, of which there is conjectured to be an infinite number. Are there also infinitely many sets of three or more consecutive primes in arithmetic progression with a given common difference? An intriguing question!

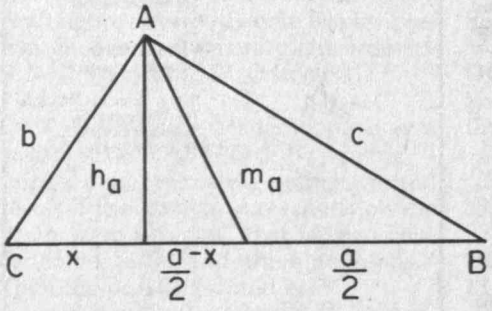
We are asked to find a set of three consecutive three-digit prime numbers in arithmetic progression with common difference 12. One such set is found to be 199, 211, 223. Again, we are asked to find a set of four consecutive three-digit prime numbers in arithmetic progression with common difference 6, and the set 251, 257, 263, 269 is found.

The last question asked is what is the longest string of consecutive prime numbers in arithmetic progression with common difference 4. The surprise answer is that the longest possible string consists of only two primes. Consider the first member of such a string. Since it is prime, its remainder when divided by 3 must be either 1 or 2. If the remainder is 1, then the next prime in the string (just add 4 to the first) will leave a remainder of 2 when divided by 3, but the third will be exactly divisible by 3, so it can't be prime. Thus the length of the string is two. And if the remainder when the first member of the string is divided by 3 is 2, then the string will have length one, since the next number (add 4) will be divisible by 3, so it can't be prime.

Also solved by Phelps Meaker, Frank Carbin, R. Way, Sidney Feldman, David Evans, Peter Hagelstein, Leo Harten, Richard Hess, Matthew Fountain, and the proposer, Larry Bell.

M/J 5. For any triangle, the sum of the squares of the medians to the sum of the squares of the sides equals a constant rational number. What is this number?

Here is what Farrel Powsner describes as "the most publishable solution":



In the diagram, we have triangle ABC with altitudes h_a, h_b, and h_c and medians m_a, m_b, and m_c to sides a, b, and c, respectively. (In order to simplify the diagram, m_a and h_a are the only segments interior to the triangle that are drawn.)

m_b and h_b separate $\overline{CA}$ into segments whose lengths are

$\frac{b}{2}$, $\frac{b}{2} - y$, and y.

m_c and h_c separate $\overline{AB}$ into segments whose lengths are

$\frac{c}{2}$, $\frac{c}{2} - z$, and z.

Using the Pythagorean Theorem gives the results shown in the box above.

Summing II and III and setting the results equal:

$x^2 + y^2 + z^2 = (a - x)^2 + (b - y)^2 + (c - z)^2$

$x^2 + y^2 + z^2 = (a^2 + b^2 + c^2) + (x^2 + y^2 + z^2) - 2(ax + by + cz)$

$2(ax + by + cz) = a^2 + b^2 + c^2$

$ax + by + cz = \frac{1}{2}(a^2 + b^2 + c^2)$. (1)

Summing I and expanding:

$m_a^2 + m_b^2 + m_c^2 = (h_a^2 + h_b^2 + h_c^2) + \left(\frac{a^2}{4} + \frac{b^2}{4} + \frac{c^2}{4}\right) + (x^2 + y^2 + z^2) - (ax + by + cz)$. (2)

Now, summing II:

$x^2 + y^2 + z^2 = (a^2 + b^2 + c^2) - (h_a^2 + h_b^2 + h_c^2)$. (3)

Substituting (1) and (3) into (2):

$m_a^2 + m_b^2 + m_c^2 = a^2 + b^2 + c^2 + \frac{1}{4}(a^2 + b^2 + c^2) - \frac{1}{2}(a^2 + b^2 + c^2)$.

Therefore,

$m_a^2 + m_b^2 + m_c^2 = \frac{3}{4}(a^2 + b^2 + c^2)$. And

$\frac{m_a^2 + m_b^2 + m_c^2}{a^2 + b^2 + c^2} = \frac{3}{4}$.

Therefore, the ratio of the sum of the squares of the medians of any triangle to the sum of the squares of the sides is $\frac{3}{4}$.

Also solved by Mary Lindenberg, Jack Hiatt, John Prussing, Raymond Gaillard, Norman Spencer, Ken Haruta, Steve Shapiro, Frederick Furland, R. Way, Naomi Markovitz, Phelps Meaker, Sidney Feldman, Peter Hagelstein, David Evans, Henry Lieberman, Ronald Raines, Richard Hess, Matthew Fountain, and the proposer, Harry Zaremba.

Better Late Than Never

F/M 4, F/M 5 Raymond Gaillard has responded.

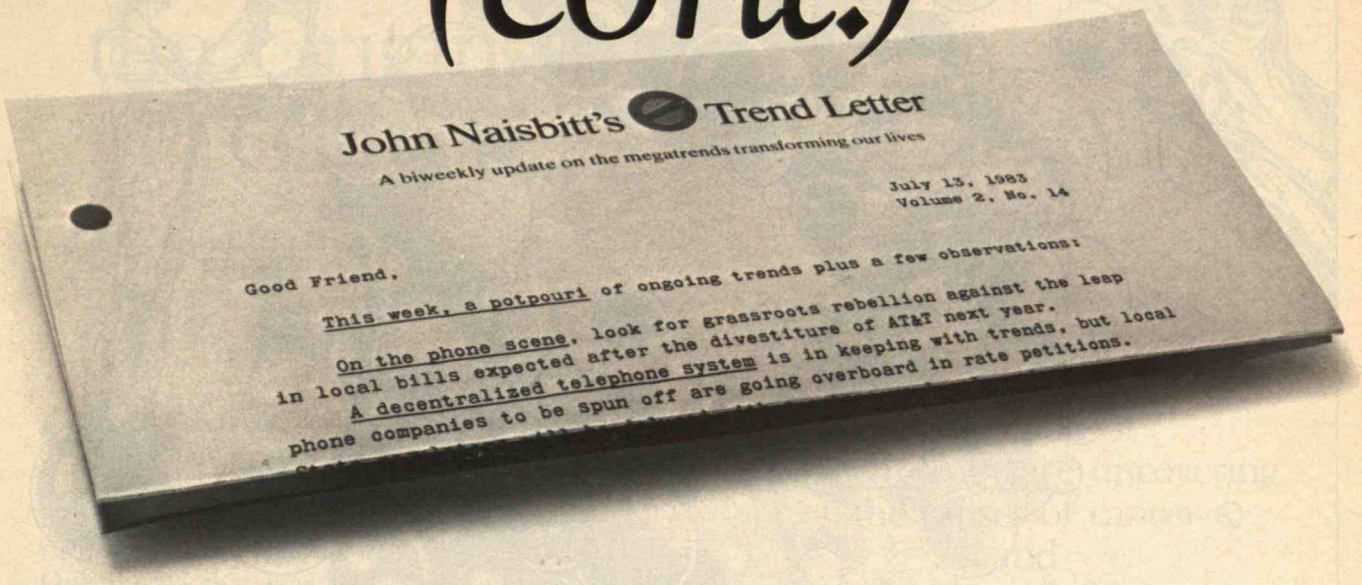
Proposers' Solution to Speed Problems

OCT SD1. All equal their logs except for position of decimal point [I didn't get it either—Ed.].

OCT SD2.

Initial	0	0	0	24
24-13	0	0	13	11
13-5	5	0	8	11
13-11	5	8	0	11
5-13	0	8	5	11
24-13	0	8	13	3
13-5	5	8	8	3
5-24	0	8	8	8

Megatrends (cont.)


John Naisbitt's Trend Letter

A biweekly update on the megatrends transforming our lives

July 13, 1983
Volume 2, No. 14

Good Friend,

This week, a potpourri of ongoing trends plus a few observations:

On the phone scene, look for grassroots rebellion against the leap in local bills expected after the divestiture of AT&T next year.

A decentralized telephone system is in keeping with trends, but local phone companies to be spun off are going overboard in rate petitions.

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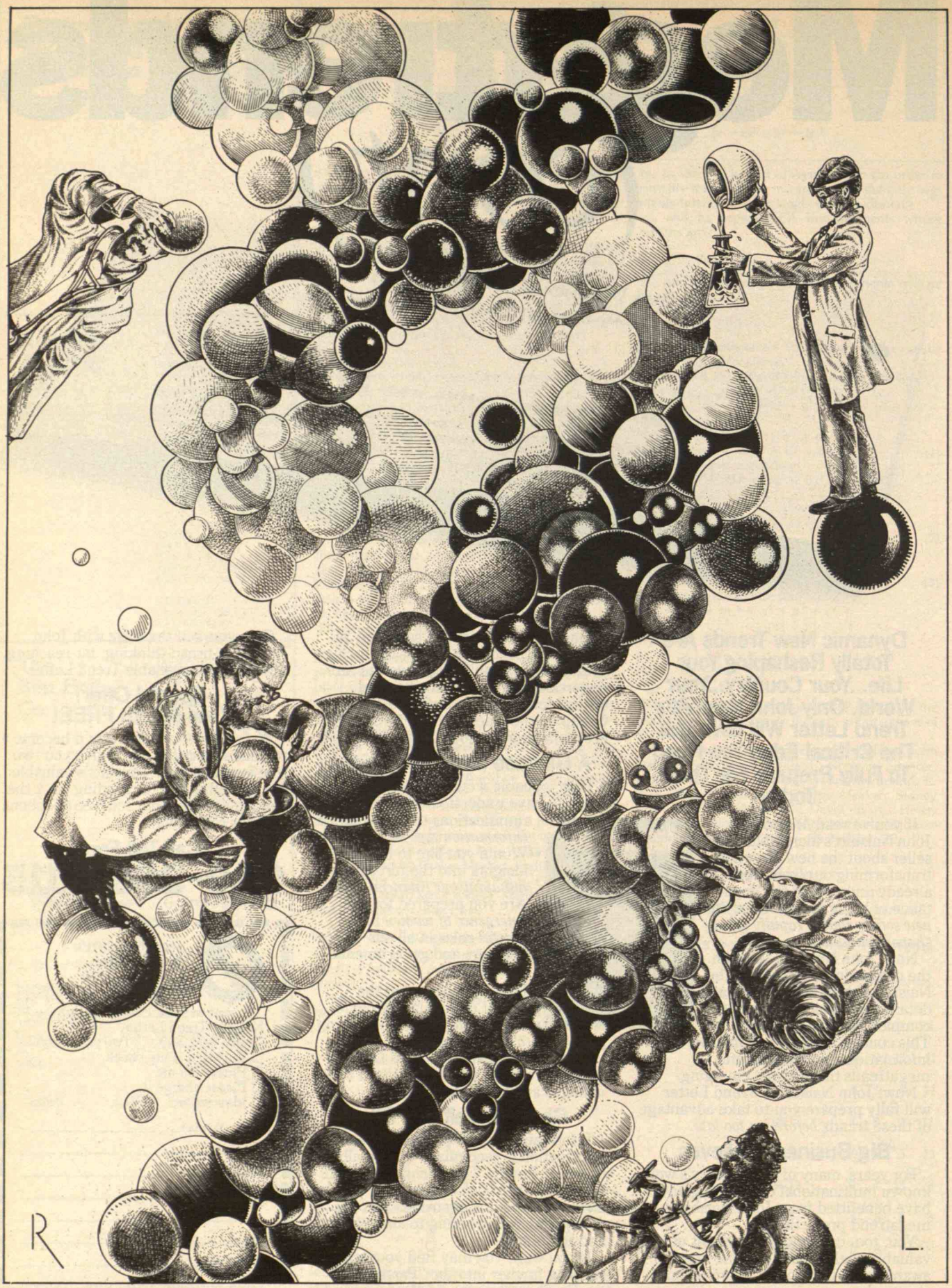

R
L.

The Search for the Origins of Cancer

BY ROBERT A. WEINBERG

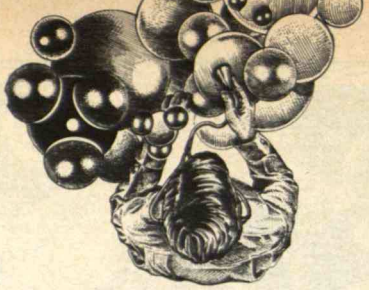
New tools of biotechnology are uncovering the causes of cancer and may be instrumental in finding a cure.

SCIENTISTS are rushing headlong into new ways of thinking and learning about life processes. Biotechnology has enabled us to reach into the blueprint of living matter—deoxyribonucleic acid, or DNA—and break it down into its simple components. One puzzle that was intractable without the new techniques, and that researchers have lately begun to solve, is the mechanics of carcinogenesis—the process by which normal cells are converted into cancer cells. A description of what has been learned about cancer, and how this knowledge was gained, should make clear how important biotechnology has been to the research, and how much it is likely to contribute.

The story could well begin with Gregor Mendel, the Austrian monk and botanist whose ten years of work breeding pea plants yielded the first important insight into the nature of heredity. His experiments, conducted in the middle of the last century, showed that each of the plant traits studied, such as height or seed shape, was determined by a single, separate packet of hereditary information—what scientists were eventually to term a "gene."

As most biology students know, Mendel's papers sank into obscurity, like stones tossed into a pond. It was not until 1905 that his principles were rediscovered, by three scientists (Hugo de Vries, Carl Correns, and Eric von Pschermak-Seysenegg) working independently of one another. It was they who put Mendelian genetics at last on a firm footing. During the 20 years that followed, a picture emerged, based largely on work with fruit flies, showing that the more complex traits of animals are likewise determined by an array of genes, each one serving as a template for some physiological or morphological characteristic. We now know that the genes, working

ILLUSTRATIONS: ROGER LEYONMARK



in concert, tell a fertilized egg how to divide and develop into the myriad cells that form an organism; the genes also tell the cells in the fully developed organism how to function. The manipulation of these arrays of genes became the science of genetics.

Genetics was, and remains, a mathematical abstraction; it is a dry science attempting to describe wet life. Though genetics could reach far, in the end it could not provide a material description of the symbols that make up its vocabulary—that is, of the genes themselves. The precise substance of these packets of information remained obscure.

Another discipline—biochemistry—was necessary to settle the question; Oswald T. Avery, Maclyn Macleod, and C.M. McCarty conducted the key experiments 40 years ago at the Rockefeller Institute, in New York City. The researchers were initially interested in the bacterium *Pneumococcus*, and its ability to induce pneumonia in mice. They used two strains of *Pneumococcus*, one virulent and the other lacking any ability to trigger infection. When heat-killed, virulent bacteria were mixed with their live, benign counterparts, the result was unexpected: some of the benign bacteria began to behave as if they, too, were virulent.

Two conclusions were evident. First, the genetic information dictating virulence had somehow survived the death of the virulent bacteria. Second, and of paramount importance, the information for virulence must have been transferred from the dead bacteria to the live ones, altering their behavior. Once it became clear that a gene or genes could be transferred from one bacterial cell to another, the researchers needed only to identify which chemical in the cell served as the vehicle for the transfer.

A bacterial cell, like human cells, consists of a complex array of biochemicals: fats, carbohydrates, proteins, and the nucleic acids—DNA and RNA. By a process of elimination, Avery, MacLeod, and McCarty found that when one of the nucleic acids, DNA, was selectively destroyed, none of the mice contracted pneumonia. Therefore, the scientists reasoned, no information transfer had occurred. They concluded that DNA must be the molecule that stores and carries genetic instructions.

Although the work at the Rockefeller Institute established the crucial importance of DNA in biological processes, another decade passed before James Watson and Francis Crick uncovered the details of its physical structure. (The thirtieth anniversary of their announcement was celebrated in March of this year.) Watson and Crick found that the DNA molecule stores information in two long strings of chemical bases, known as nucleotides, wound around each other to form a double helix. The sequence of the nucleotides (adenine, cytosine, guanine, and thymine—abbreviated as A,C,G, and T) encodes information in much the same way that a sequence of letters constitutes a word. We now think of a gene as a sequence of nucleotides with a definite beginning and end, its text dedicated to a specific biological function. Ninety years after Mendel, the chemical nature of his hereditary packets was finally reduced to structurally simple molecules.

The Expression of the Code

The problem of cancer would seem to be far removed from these lessons in basic molecular biology. Perhaps this apparent distance stems from the great difference in scale between a tumor and its constituent cells, and the molecules of DNA within each cell. Although the complexity of the problem would seem to be reduced appreciably once single cancer cells are accepted as legitimate and useful objects of attention, the puzzle that the disease presents remains frustrating. When one compares the traits, or "phenotypes," of a cancer cell with those of its normal antecedent, one arrives at a long—and still growing—list of differences. Cancer cells have unusual shapes; they interact in special ways with their neighbors; they do not take up nutrients in the same way that normal cells do; and their metabolism tends to be less dependent on oxygen. Dozens of other differences could be cited. Clearly, many cellular traits must change during the transition from a normal to a cancerous state.

By the early 1970s, scientists were considering two alternative strategies to explain these shifts in a cell's priorities. The first, a "genetic" mechanism, held that during cancer's initial stages, a cell's genes become altered—mutated—and, as a consequence, so do the traits that they specify. This hypothesis followed a long tradition in biology: witness the *Pneumococcus* experiment, in which a slightly altered gene strongly influenced bacterial behavior. The second strategy is sometimes called the "epigenetic" mechanism. We know that all of the cells in an organism do not behave identically, even though each cell carries the same set of genes—that is, the organism's full genetic

Among the tens of thousands of genes in the tumor cells, one gene with overriding power could push a cell into the cancer state.

repertoire, or "genome." Apparently, no alteration occurs in the genes of a human liver cell to make its behavior different from that of a brain cell. Instead, each cell type seeks out parts of the common blueprint for its special instructions. (How cells direct their attention to distinct portions of the genome is the central problem now before developmental biologists.) An analogy might be a multitude of religious sects, each justifying its doctrines on the basis of the selective reading of a common bible. Perhaps the cancer cell runs amok not because it carries an altered text (abnormal genes), but because it reads the normal text (normal genes) in an idiosyncratic way.

These countervailing theories of cancer, genetic and epigenetic, led my group at M.I.T. to perform an experiment in 1978 that we hoped would determine which of the two hypotheses was valid. Our plan was simple: we would extract DNA from a tumor cell, introduce the DNA into a normal cell, and observe the behavior of the recipient. By first extracting the DNA, we would be preparing a pure genetic text, unencumbered by any of the traditions of interpretation that might have developed within the tumor cell. Any alteration in the behavior of the normal cell that acquired this DNA would necessarily reflect the influence of the genes themselves.

Although these experiments rested on the same principle of gene transfer employed by the scientists at Rockefeller in the 1940s, the techniques used were different. The earlier experiments involved the transfer of DNA into bacteria, but we needed to transfer DNA into mammalian cells—a more formidable undertaking, since these cells are not as receptive to the incorporation of foreign DNA fragments. Our research would not have been possible without the development, begun only five years before, of new, more efficient gene-transfer techniques. Study of cancer is not their only application, by the way; research on a variety of biological problems has been helped.

The procedure we employed—one that is now routine in research laboratories—involves mixing DNA molecules in a calcium phosphate solution. The crystals that form in this solution are, for obscure reasons, taken up avidly by certain types of cells grown in Petri dishes, such as those of connective tissues ("fibroblasts"). The donor DNA carried in with these crystals is then expressed in the recipient cells, changing their behavior.

Our experiments began with mouse cells, which had been converted into tumor cells as a result of exposure to the chemical carcinogen 3-methylcholanthrene. We introduced the DNA of these tumor cells into normal mouse fibroblasts, which form layers one cell thick in a petri dish. Some of these cells began to replicate abnormally, creating thickened clumps that could be discerned easily by the naked eye.

This result showed, in one stroke, that the DNA of the tumor cells had carried the information for making the normal cells cancerous. Moreover, not only did the recipient cells grow abnormally in the Petri dish; when we injected the cells into live young mice, they soon developed tumors. Thus, the behavior of the original cancer cells could be traced to a genetic, not epigenetic, cause.

The next stage of our experiments addressed a puzzle created by the results of the first. Let us say that 20 traits of the recipient cells were altered by the tumor DNA. Were we to infer that the recipient cells had acquired 20 separate, cancer-related genes from the donor cells? The answer began to appear much simpler. No matter how we manipulated the donor DNA—cutting it into pieces for example—we found that the recipient cell either remained unchanged or acquired all the cancerous traits simultaneously. It seemed that a single segment from the donor cell's DNA had elicited the changes. This segment appeared to have all the properties of a cellular gene. Therefore, while the first stage of our experiment vindicated the genetic model of cancer, the second stage extended the model: at least in this case, alteration of the normal cell rested on a single genetic segment, not many.

We had detected, among the tens of thousands of genes in these tumor cells, the presence of one gene with overriding power—a master control that was able to push a cell into the cancer state. Such control sequences have been named "oncogenes." They are conductors on the cellular podium, not musicians playing in the back rows. They orchestrate the music, or rather, the cacophony of cancer cells.

Eventually, studies conducted at the Dana-Farber Cancer Institute in Boston, the Cold Spring Harbor Laboratory on Long Island, and the National Cancer Institute in Bethesda, Md., as well as by my own group, turned up evidence of cancer-provoking genes in the DNAs of various human tumor cells. These DNAs behave just like those of tumorous mouse cells. The studies confirmed not only that the mechanism of carcinogenesis can be very similar in mice and

By good fortune, cloning techniques allowed us to retrieve any gene we chose and study it in splendid isolation.

human beings, but also that the mechanism can be similar from one type of human tumor to another. Such findings give us reason to hope that cancer may eventually be understood in terms of a small number of mechanisms common to all tumors, rather than hundreds of mechanisms, each characteristic of a different type of tumor.

Finding the Critical Sequence

The oncogene would remain only an abstraction until it could be isolated, and its anatomy fleshed out. Such an undertaking seemed ambitious. The DNA of a single mammalian cell consists of about 6 billion nucleotides; within this jungle of information lie the sequences of between 50,000 and 100,000 genes—the precise number is unknown. The oncogene was well hidden.

By good fortune, techniques to isolate genes—"cloning"—became available shortly before we needed them. Cloning allows scientists to retrieve any gene they choose, and study it in splendid isolation. The techniques depend upon the fact that the blueprint of all cellular life is DNA. Because DNA's basic molecular structure is the same in every organism (only the specific sequences differ), the DNA of one organism is chemically compatible with that of another. Thus, a segment of DNA from a fly or a human being can easily be joined to the DNA of a bacterium. The bacterium will then nurture and replicate the foreign DNA segment as if it were one of its own.

Such bizarre translocations of genetic information are rare. We do not exchange genetic information with bacteria, even the billions living in our guts. Nor do animal species seem to exchange much information among one another. But bacteria do so frequently, and their genetic plasticity can be used to clone the genes of organisms higher on the evolutionary scale.

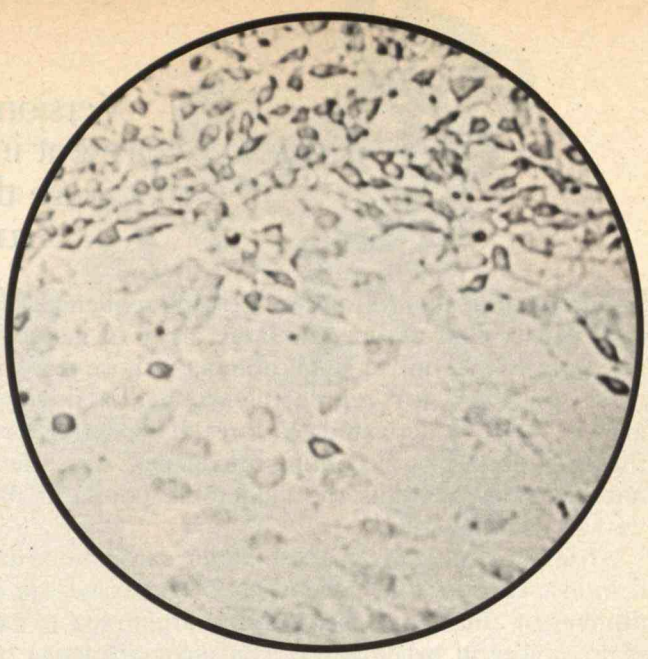
Using enzymes, we are able to divide the DNA of the mammalian cell into hundreds of thousands of pieces and introduce each piece into a separate bacterium. Each bacterium then becomes a "chimera" carrying its own and some foreign DNA. (The term derives from the hybrid beasts of mythology, such as the griffin, which had the head of an eagle and the body of a lion.)

Some scientists accomplish the transfer by means of bacterial plasmids—extra DNA molecules residing in bacteria and tolerated even though they are not part of the bacterial genome. Bacteria themselves employ these plasmids as vehicles to exchange information. Copies of a plasmid, and with it, attached copies of the mammalian DNA segments, can be introduced into bacterial cells and will persist in all of the cells' millions of descendants. These genetically identical offspring will form a colony on a petri dish, from which they can be removed for further study.

An alternative strategy exploits the viruses that prey on bacteria, known as "bacteriophages." (Although the bacteriophages are unrelated to the viruses that ravage cells of the human respiratory tract, they operate in the same way. A single virus particle injects its genetic information into a bacterial cell, and this information directs the cell to make hundreds if not thousands more virus particles, which eventually burst out to infect other cells.) The genes of a bacteriophage can be manipulated to accept a foreign DNA segment, such as one from a mammalian cell. When the chimeric bacteriophage reproduces itself, each of its millions of descendants, present on one area of the petri dish, will carry a copy of the foreign piece of DNA.

Researchers at several institutions, including those of us at M.I.T., have chosen the bacteriophage strategy to isolate and study the oncogene. First, one breaks up the DNA of a human tumor cell into thousands of segments at random. One does not have to divide the gene sequences at their precise boundaries, because, as it turns out, a DNA molecule is usually many times larger than the genes it carries. Much of the molecule is made up of nucleotide sequences that are the genetic equivalent of noise, having no apparent cellular function. Thus, one can break a DNA molecule into several hundred thousand pieces confident that most of the 100,000 genes will, by chance, be entirely included within one or another of the fragments. The fragments are then inserted into separate bacteriophages, which are in turn used to infect bacteria growing on petri dishes. The presence of the infecting bacteriophages is indicated by the "plaques," or holes, that they and their descendents erode in the layer of bacteria on each dish. Of the several hundred thousand plaques, one plaque should contain the bacteriophages carrying the inserted DNA of special interest—the elusive oncogene.

Of course, one must still find a way to identify this crucial plaque. In fact, such identification is an obstacle in all gene cloning procedures, not just those enlisted to clone oncogenes. The problem has taxed



DNA extracted from human tumor cells and introduced into normal mouse cells produces cancerous characteristics in these cells. This photograph shows the higher density and altered shape of the transformed cells (in the top of the photo) as compared with the normal cells (below). Techniques of gene transfer are allowing scientists to unfold the mysteries of cancer.

the cleverness of a number of molecular biologists, who have responded with a wide variety of strategies.

Our own solution began with the introduction of DNA from a human bladder carcinoma into mouse cells. We isolated some of the cells thus transformed, extracted their DNA, and used the DNA in turn to transform yet more normal mouse cells. In this way, we were able to engineer mouse cells carrying only small amounts of human DNA—the DNA carrying the oncogene, if the procedure worked according to plan. The DNA of this mouse cell was then itself fragmented and inserted into bacteriophages. To identify the oncogene, we had only to identify the bacteriophage plaque carrying human, rather than mouse, DNA. Fortunately, we could accomplish this task fairly easily, by means of several experimental sleights of hand.

In the end, we isolated a bacteriophage carrying a human DNA segment 6,000 nucleotides long. Research groups led by Michael Wigler of Cold Spring Harbor and Mariano Barbacid of the National Cancer Institute, using different methods, reached this goal at about the same time. A consensus evolved from the combined results: the oncogene of the bladder carcinoma cells had been cloned. No longer a hypothetical entity, it could be virtually laid out on the workbench, unsullied by the thousands of other sequences in the tumor-cell DNA, and dissected.

Dissection depended on two biochemical tricks. First, we used "restriction enzymes," which recognize specific nucleotide sequences in DNA (such as GAATTC) and cut it at those points. The enzymes allowed us to delineate distinct domains within the otherwise featureless terrain of the oncogene. Next, a collaborator of ours subjected a portion of the oncogene to the ultimate scrutiny: sequencing. Using biochemical techniques, he identified each one of the hundreds of nucleotides composing that domain within the gene. Other researchers, working at Genentech, the California-based bioengineering company, eventually sequenced all 6,000 nucleotides of an oncogene. Ten years ago, determining the components of a gene just 20 nucleotides long was an awesome achievement. Rumor has it that this year, a British group has sequenced a DNA molecule 100,000 nucleotides long. The pace of advance has been remarkable.

By sequencing the cloned oncogene, we expected to learn the details of its structure and, perhaps further down the road, how it sets in motion the chain of cellular events that initiates cancer. (In the end, needless to say, the oncogene's function is more interesting than its structure.) Almost all genes induce cells to make specific proteins. By deciphering the oncogene's sequence, we confirmed that it serves as a template for the synthesis of a 21,000-molecular-weight protein. This protein, and not the gene itself, is the direct agent of change in cells. By interacting with the other components within a cell, the oncogene protein is able to induce simultaneously a number of the traits typical of cancer cells—to derail the normal cell and force it toward the cancer state. Unfortunately, the structure of this 21,000-molecular-weight protein reveals little about just how the protein does its work. In fact, a major embarassment of molecular biologists is that we know the structure of hundreds of proteins without having a clue as to how they function.

Happily, not all of the problems in oncogene research are so stubborn. For example, once the oncogene was cloned, it was not hard to discover its origin. Two alternatives were possible. The oncogene might have been a foreign gene forced upon a bladder cell during the process of carcinogenesis, or it might have been indigenous, emerging from the cell's existing repertoire of genes. A technique sensitive enough to answer the question — the Southern procedure, named after its developer, E.M. Southern of the University of Edinburgh — is yet another of biotechnology's significant achievements. (When similar techniques for analyzing proteins and RNA were announced, they were dubbed the Western and Northern procedures. Editors of molecular biology journals will tolerate the most outrageous nomenclature if it works.)

The Southern procedure enabled us to discover, literally overnight, a simple fact: the oncogene had arisen from a closely related progenitor residing in the normal cellular genome. This confirmed the suspicion of many that the oncogene had been created by

Versions of cancer genes were present in the primitive organisms that were the ancestors of fruit flies.

mutation—the alteration of an existing sequence. We now believe that among the large array of genes in any human cell, only a small number—those responsible, perhaps, for regulating the cell's normal growth—can be activated (as a result of damage to the cell's DNA) into becoming oncogenes. These few normal genes are thus the vulnerable points in the human genome.

At least in the case of the bladder carcinoma, the demonstration of the oncogene's origin ruled out a number of alternative theories that attempted to explain cancer in other ways. The most attractive of these was the viral theory, which blamed the presence of the oncogene on an earlier infectious event. Viruses, after all, are known to carry a variety of genetic material into the cells they infect. Some strains of so-called "tumor viruses" import an oncogene that can force an infected cell to spawn a large progeny of tumor cells. But though a number of tumor viruses have been found in various animal species, their role in human carcinogenesis seems, so far, minor. Certainly in the case of the bladder carcinoma, the Southern procedure proved that the oncogene had not been brought in by a virus. Instead, it seems more likely that chemicals in urine, arising naturally or from an environmental insult, such as cigarette smoke, damaged a normal gene residing in one of the cells lining the bladder. The genetic damage converted the normal gene into an oncogene, thus triggering the process of carcinogenesis.

The powerful techniques of biotechnology allowed us to answer another obvious question. What was the precise nature of the mutation that changed the normal gene into an oncogene? When a collaborator of the M.I.T. group compared the nucleotide sequences of the two genes, he came up with a surprisingly simple answer. The genes, each 6,000 nucleotides long, differed in a single critical nucleotide: a G at one site had been replaced by a T. This "point mutation" had been enough to create a potent oncogene, changing the structure of the protein encoded by the gene. With its altered amino-acid sequence, the 21,000-molecular-weight protein had acquired new powers and could begin to wreak havoc in the cell.

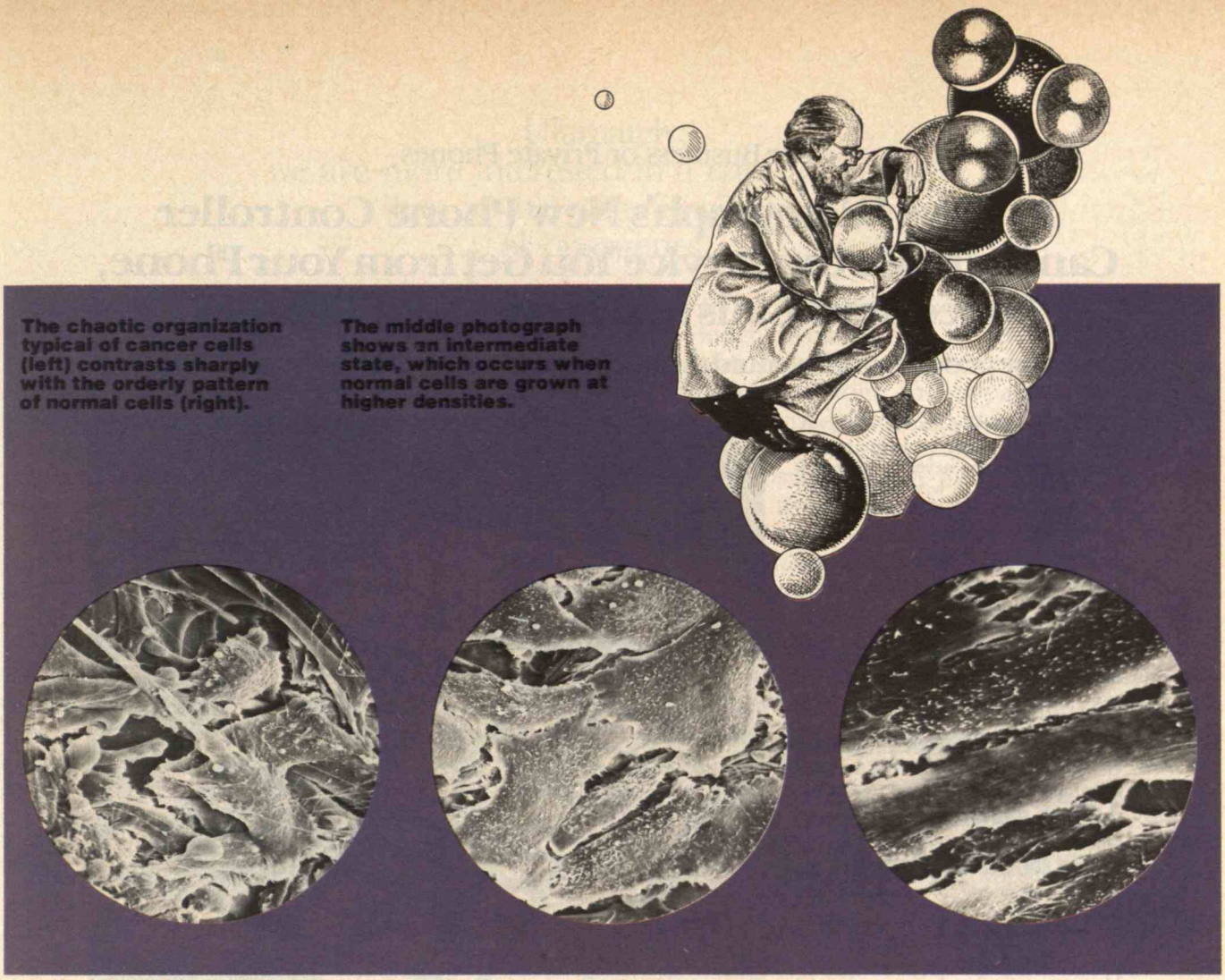
Why Cancer Is Rare

At M.I.T., we recently came across a tumor that has revealed still more about the process of cancer. In fact, it was not a tumor at all but rather a tumor "cell-line"—cells removed from a cancer patient and adapted to grow in a petri dish. (Cell-lines can grow forever under the proper conditions, making them extremely convenient subjects for experimenters. And although it is never acknowledged, the use of these cell-lines, instead of human tumors, also allows researchers to remain at a safe distance from the human costs of a terrible disease.) The cell-line we investigated was cultured from a promyelocytic leukemia. This unusual leukemia assaults the cells in bone marrow that contribute to the body's many-faceted immune-defense system.

We were not concerned with the vestigial immune functions exhibited by these tumor cells, however. Instead we were obsessed, as usual, with their oncogenes—with the molecular elements that incessantly drove these cells into uncontrolled growth. Gene transfer allowed us to detect an oncogene in the DNA of these leukemia cells that is very similar to the one we had found earlier in the bladder carcinoma. The two genes are members of the same "family"; they produce similar 21,000-molecular-weight proteins that behave almost identically. (Molecular biologists do not think of family relationships in the same time scales that genealogists do. The two cousin oncogenes descend from a common ancestor gene that existed not generations ago but 3 or 4 hundred million years ago.)

The leukemia oncogene that we detected, called a "*ras* gene," had been created by a small mutation similar to that responsible for creating the oncogene of the bladder carcinoma. But the leukemia oncogene had company in the cancerous cell. Groups at the Fred Hutchinson Cancer Center in Seattle and the National Cancer Institute found a second oncogene in cells from the same leukemia—this one termed "*myc*." The *myc* gene proved to have been activated in an entirely different way. Instead of being present in two copies per cell, as all well-behaved genes are, the *myc* gene had generated between 60 and 80 copies of itself. It had somehow cut the tethers to its neighbors on the double helix and started its own program of replication.

Activation of an oncogene by means of such selective amplification had been observed before. Much more intriguing was the more fundamental discovery that these leukemia cells carried two kinds of active oncogenes—the *ras* and the *myc*. Clearly, each must confer a separate advantage on the tumor cell; otherwise, why should two have developed? The dis-



The chaotic organization typical of cancer cells (left) contrasts sharply with the orderly pattern of normal cells (right).

The middle photograph shows an intermediate state, which occurs when normal cells are grown at higher densities.

covery of a second oncogene in a single cell helped to explain why it usually takes people so long to contract cancer; often 20 or 30 years elapse from the start of the process to the appearance of a tumor. The transformation of a normal cell to a cancerous one does not seem to happen in one step; instead, scientists believe that it depends on a succession of alterations. Could it be that these two oncogenes offered proof, at the molecular level, of this suspicion—that they represent two of the steps in the process?

Hartmut Land and Luis Parada of M.I.T. tested this hypothesis, by taking some normal cells from a rat embryo and observing the effects of the two oncogenes on them. When a *ras* or a *myc* oncogene alone was transferred into rat embryo cells, no visible alteration ensued. Here, a single oncogene, acting on its own, was incapable of converting a normal cell into a tumor cell. But when the two oncogenes were introduced together into embryo cells, the conversion did take place. It was clear that the cooperation of these two genes was required for the change.

This finding seemed to conflict with the earlier experiments that showed a single gene initiating cancer. We were forced to conclude that the mouse cells we had used before were abnormal; when they were cultured by others, they must somehow have been inadvertently primed to become cancer cells, so that our addition of only one oncogene was sufficient to push them over the brink. Although we have not yet confirmed this inference in the laboratory, we believe that extensive culturing gave these mouse cells a head start, endowing them with one or more oncogenes long before we manipulated them for our own purposes.

The discovery that multiple oncogenes must cooperate to create a cancer cell points to the manifold wisdom of evolution. If cancer could occur in only one step, then the body might develop new tumors every day. Even though the odds that an oncogene would be created in any given cell would be low, the odds that an oncogene would be created in some one of the trillions of cells in the body would be high. But a process requiring multiple rare events occurs far less frequently—its probability is the product of the low probabilities of each event. This may explain why cancer is not a more frequent catastrophe. Evolution has protected the human body by endowing cells with a number of hurdles between the normal and the cancerous state.

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Ultimately,
we are more interested in a cure for cancer
than in the esoteric workings
of oncogenes.

More Puzzles

The tools of biotechnology will continue to propel cancer research forward. The process I have described only begins to lay out the control networks of the cancer cell. The next challenge is to figure out how the oncogene proteins work. This research is likely to proceed in at least two directions.

Some scientists will be studying in detail the proteins that oncogenes encode. The primary structure of such a protein—the sequence of the 20 different amino acids specified by an oncogene—has been worked out. The problem is that, unlike the nucleotide chains of DNA, which always form a double helix, the amino-acid chains of proteins assume an infinite variety of configurations. They loop back on one another like jumbles of yarn. Knowing the sequence of amino acids does not enable scientists to predict the chain's ultimate shape, and thus the protein's biochemical activities cannot even be guessed.

Biotechnology offers a means of attacking this dilemma. The same bacteria that scientists have used to carry copies of an alien gene can be induced to synthesize the alien protein encoded by the gene. Indeed, proper engineering of the cloned DNA can force a bacterium to devote as much as several percent of its synthetic effort to producing the protein of interest. The protein may be a hundred or even a thousand times more concentrated in the bacterial cell than in its normal mammalian host cell. Because bacteria can be grown in large numbers relatively cheaply, those of us in cancer research will soon have large amounts of pure oncogene protein to study, whereas at present we have only minute amounts of impure protein samples, which are exorbitantly expensive to prepare.

Other scientists will look for the genetic components of cancer in organisms never before associated with the disease. In a sense, we will be stepping back from the breakthroughs in manipulating mammalian oncogenes and their normal precursors. If we can understand how oncogenes function in simpler organisms, then a complete picture of the more complex mammalian function might be easier to draw.

Two summers ago, our research group found a relative of the human *ras* oncogene in the fruit fly *Drosophila*. The discovery was tantalizing, because it showed that versions of the oncogenes were present in the primitive multicellular organisms that were the ancestors both of *Drosophila* and of human beings. However, a more important corollary than this followed from the discovery. The *Drosophila* has been so thoroughly studied that its genome is a genetic erector set. Now workers can begin tinkering with the *Drosophila* genome to learn about the activities of an oncogene—putting in copies of the *ras* gene here, taking them out there, and observing the effects on the organism. Contrary to the cartoons in newspapers, such tinkering with human genomes is not within short reach; human DNA is far too complex.

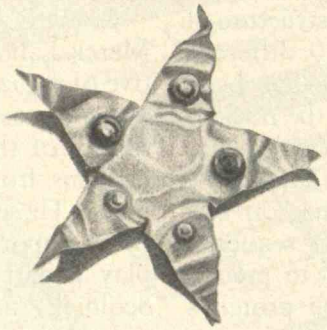
Recently, Edward Scolnick and his group at the Merck Laboratories in West Point, Pa., found a relative of the *ras* oncogene among the genes of common baker's yeast. Their discovery further extends the antiquity of the *ras* gene back to the single-celled organisms from which all multicellular creatures descend. These *ras* genes seem to have been doing something important for cells long before they began to play a part in cancer. But the real significance of Scolnick's finding relates to its potential contribution to knowledge of the oncogene's function. By studying the *ras* gene and its encoded protein in one of the simplest organisms, researchers should be able to penetrate deeper still into the fundamental mysteries of how oncogenes work.

The near goal in cancer research is to chart out the complex regulatory pathways that govern when cells grow and when they rest. By the end of this decade, we should see the outlines of these pathways—the interlocking networks that are supposed to keep a cell in balance and prohibit runaway growth. We should be drawing arrows and boxes, sketching out the circuit diagrams of both the normal and the damaged cell. And when we truly understand the circuitry, then one day, with luck, we should be able to repair its malfunctions, by means of a drug that can reset some vital control switch.

Ultimately, we are all more interested in a cure for cancer than in the esoteric workings of oncogenes. One hopes that an understanding of what goes wrong in a cell will suggest a way to reverse the processs. That a cure will arise from molecular research is less than certain, however. After Pasteur showed how bacteria cause infections, half a century passed before effective treatment—antibiotics—could be introduced. For my own part, I cannot believe that the cancer cure will keep us waiting so long.

ROBERT A. WEINBERG is a professor in M.I.T.'s Department of Biology and Center for Cancer Research and in the affiliated Whitehead Institute for Biomedical Research.

The U.S. machine-tool industry, which makes the master tools of our economy, is in trouble. The problem lies directly in management.



How the Yankees Lost Their Know-How

BY SEYMOUR MELMAN

THE U.S. industrial tradition has demonstrated that it is entirely possible to pay workers top wages while producing high-quality products at low prices. What it takes is systematic attention to product design, mechanization of production, and all-around plant efficiency, so that increased productivity offsets rising wages. Such measures enabled the U.S. auto industry, after World War II, to pay the world's highest industrial wages while producing the world's least expensive cars per pound. That is what "Yankee know-how" meant.

For a century prior to the sixties, U.S. industry enjoyed the highest productivity in the world, with labor productivity increasing by about 2.5 to 3 percent a year. Historians and economists recognized this growth as critical to the nation's prosperity, even while taking it for granted, as though it were an inherent aspect of U.S. life.

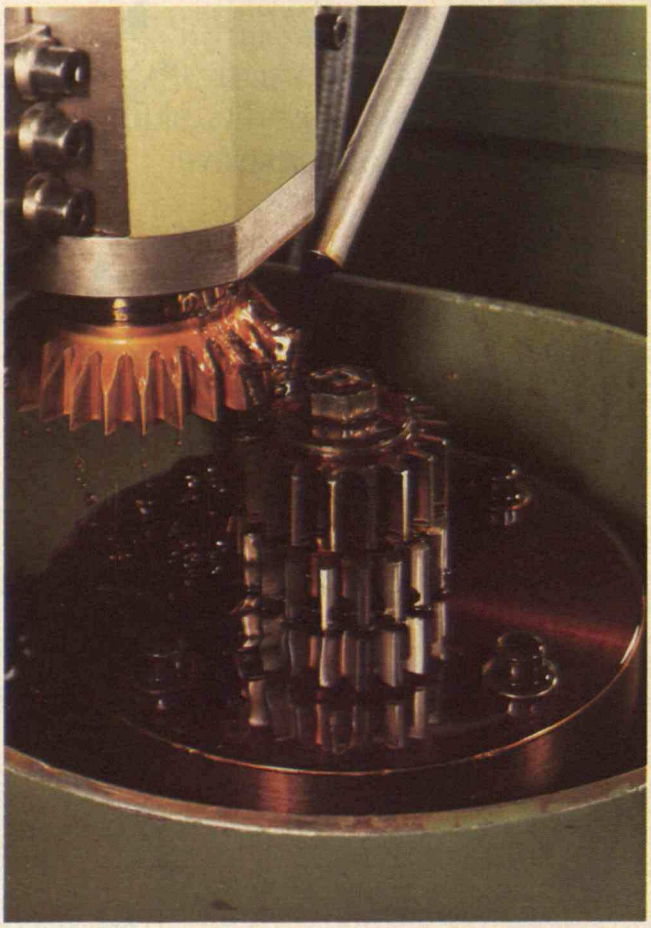
The machine-tool industry was of enormous importance in improving overall productivity. For a century after the Civil War, the United States was a star performer in producing the drills, lathes, milling machines, and other master tools essential to every industrial economy. By improving their own productivity, U.S. machine-tool manufacturers were able to pay good wages, produce industrial tools that functioned reliably under taxing conditions, yet hold costs and prices down.

The price of machine tools consistently rose more slowly than the cost of labor, giving factory managers a sustained invitation to further mechanize work. From 1939 to 1947, average hourly earnings of U.S. industrial workers rose 95 percent, while the prices of machine tools increased only 39 percent. U.S. manufacturers were well served by technically competent and cost-effective equipment, which helped improve productivity throughout the industrial system and offset the rise in wages. Thus, one industry employing

ILLUSTRATION: CAROL LA COURSE


made
in
USA

Machine tools cut and shape precision metal parts for use in almost every industry. Here, a high-speed photograph shows the manufacture of a gear.



85,000 people had a decisive effect on the entire country's manufacturing strength.

However, in the 1960s, the classic pattern of cost-minimizing in the U.S. machine-tool industry began to deteriorate. During the 1970s prices of U.S.-built machine tools rose more rapidly than industrial wages. By 1978 the deterioration had progressed so far that for the first time, the United States imported more machine tools than it sold abroad. In 1980, 25 percent of the machine tools purchased by U.S. industry were imported, and by 1982 that figure had risen to 42 percent, according to the National Machine Tool Builders Association (NMTBA).

The decline was especially pronounced in the production of advanced machine tools for nondefense industries. By mid 1981 Japan was providing 40 percent of an important new class of computer-controlled "machining centers" purchased by U.S. firms. A machining center is an exceedingly versatile piece of major equipment capable of applying many types of cutting tools to the part being fashioned. Japanese models of a quality comparable to that of U.S. products cost about 40 percent less. In 1979 the Japanese machine-tool industry produced about 14,000 machines in this new class, while the U.S. industry produced only half that number.

Year by year the factories of Western Europe and Japan have been selling increasing numbers of high-quality yet relatively inexpensive machine tools in the United States. What happened?

State Managers

In the late 1950s the U.S. Air Force, together with a team of engineers from M.I.T. and private firms, participated in what was undoubtedly the principal technological development in the machine-tool field. Financed by the air force, this project became the nation's most important effort to research, develop, and manufacture "numerically controlled" equipment. Much as the holes in the paper roll control a player piano, information stored and retrieved by a computer controls the movements of numerically controlled machine tools.

Because control information was prerecorded, skilled machinists no longer had to read blueprints and translate that information into movements of cutting tools and workpieces. Intricate metalworking operations, especially those required to shape large structural components of aircraft, could be repeated with an accuracy previously unattainable.

The firms engaged in this effort found that the cost of the equipment mattered less than its capabilities, since the air force was paying for developing the tools and soon became the most important customer. At the same time, U.S. military and space agencies were administering their contracts with companies essentially on a "cost-plus" basis. Robert MacNamara, while secretary of defense under Kennedy, introduced "historical costing" into weapons procurement, whereby costs were allowed to increase at a steady rate based on past increases, rather than being tied to actual engineering estimates.

These changes gave contracting firms a strong incentive to run up costs, particularly in an era when Keynesian economists spoke of military spending as a

Continued on page 60

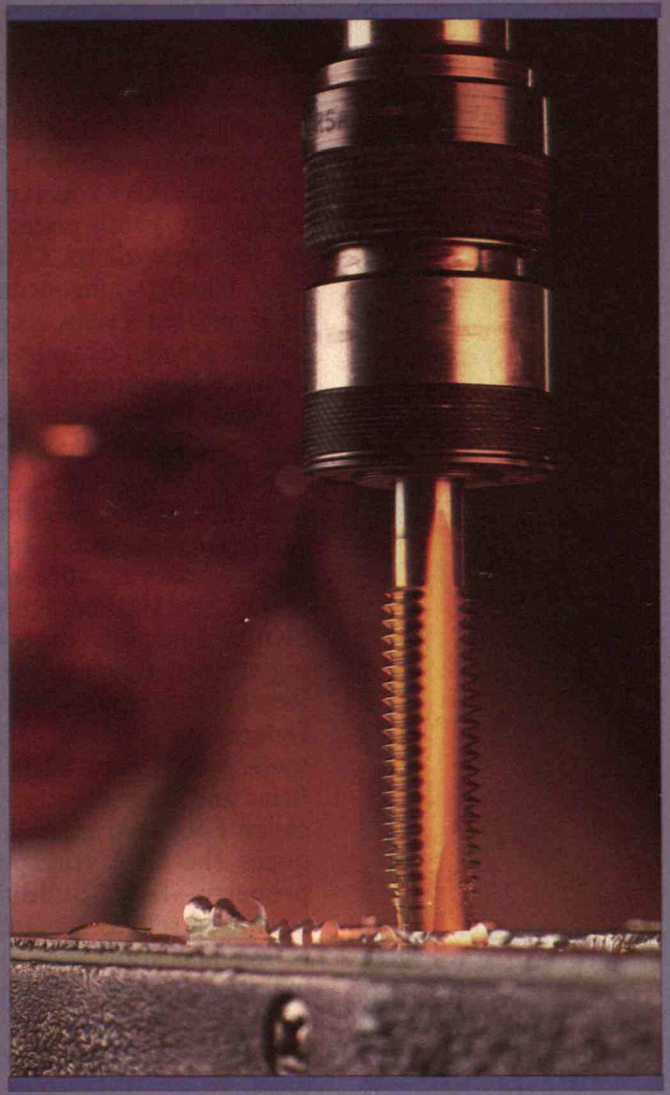
PHOTOGRAPH: BARBER COLMAN CO.

Machine Tools: The NAE Report

VIRTUALLY every major manufactured product is produced on machine tools or machines built by machine tools, a recent report by the National Academy of Engineering (NAE) points out. But that report, *The Competitive Status of the U.S. Machine Tool Industry*, concludes that "the American machine-tool industry is currently far from healthy."

This is hardly an overstatement. Orders for U.S. machine tools dropped almost 80 percent—from $1.5 billion to just over $300 million between the first quarter of 1980 and the first quarter of 1983, according to the National Machine Tool Builders Association (NMTBA). Although this decline reflects the general economic troubles of the past few years, the industry is also facing stiff competition from machine-tool builders in other countries, particularly Japan. While orders rose slightly in the second quarter of 1983, the improvement is "marginal," according to the NMTBA.

Although American machine tools are comparable in quality to those of other countries, they are usually higher priced, says Charles Pollock, spokesperson for the NMTBA. And as the NAE report points out, delivery times may run as much as 16 months behind orders. In contrast, says Pollock, thousands of Japanese computer-controlled machine tools are ready for sale in warehouses across the U.S., with delivery times usually running less than one week.



Used in drilling threaded holes in metal, this tap is coated with titanium nitride, which prolongs tool life three to six times.

An Up and Down Industry

Many of the problems that have brought the U.S. industry to its current state can be traced to the cyclical nature of the market. Relatively minor changes in the demand for consumer products tend to cause much greater fluctuations in the demand for tools to produce those products. "Take as an example a company that uses lathes for the manufacture of its products," the NAE report explains. "Assume that its manufacturing base consists of ten such lathes and that, because of wear, one replacement lathe is purchased each year. Should the company in response to demand decide to increase its output, it may find that a relatively small production increase, say 10 percent, may require the purchase of an additional lathe beyond its yearly replacement. Here a modest increase in production can lead to a 100 percent increase in the company's lathe demand." Thus, the machine-tool industry is characterized by "sweeping oscillations in sales, with great demand peaks followed by steep declines in orders." During even slight recessions, the bottom may fall out of the market.

One of the most damaging results of this cyclical market is a shortage of skilled labor. Training a skilled machinist or toolmaker may take four or five years, according to the NAE report. Yet many workers must be laid off during slack times, and some of those dismissed find jobs in other industries. The result is a chronic labor shortage during peak demand times, a situation that is unlikely to improve soon. The NAE reports that the average age of skilled machinists in the industry is 58, and the NMTBA expects a shortage of about 20,000 workers by the end of the decade.

Ironically, few U.S. machine-tool manufacturers have themselves adopted automated manufacturing techniques using advanced machine tools, which could help relieve these labor shortages. U.S. firms have found loans for modernization hard to come by because of uncertain demand: "High risk, coupled with low profit and uncertain cash flow, make the capitalization of new equipment or production processes extremely difficult," says the report.

The Roller Coaster Leveled

Why have cyclical market conditions caused such problems for the U.S. industry but not for Japanese or West German firms? The answer lies in world trade. Business cycles are not always synchronized worldwide, so weak demand for machine tools in one country doesn't imply weak demand in all others. "World trade is an

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PHOTOGRAPH: VERMONT TAP AND DIE CO./JACK McCONNELL

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important potential remedy for the cyclical domestic market variations," states the NAE. U.S. exports of machine tools currently total only 16 percent of production, while Japan exports 37 percent and West Germany exports 62 percent. Furthermore, the U.S. share of world trade in machine tools has declined steadily since the early 1960s.

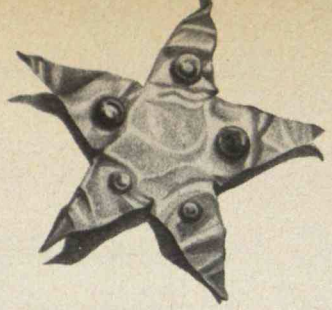
U.S. industry sources are quick to point out that government actions have discouraged exports. The most significant of these concern rulings made by the Coordinating Committee (COCOM), an international organization set up to regulate exports of high-technology goods from Western countries to Eastern Bloc nations. All NATO countries and Japan are subject to the same restrictions, but industry sources claim that the U.S. government's interpretations of COCOM's decisions are overly strict. John Deam, technical director for the NMBTA, says, "Fifty percent of the non-U.S. market for machine tools exists behind the Iron Curtain." But U.S. exports to this vast market are virtually nonexistent.

Several other government actions have discouraged the export of machine tools, according to the NAE. Regulations governing export licenses have been complicated and confusing, and loans available through the Export-Import Bank are ill suited to the limited needs of machine-tool firms. Thus, to small firms with little expertise in international trade, the obstacles involved in overseas sales may seem insurmountable.

Still, the NAE concludes that "the most compelling reasons for the decline in U.S. machine-tool exports almost certainly lie within the American industry itself." In a twisting Moebius strip of causality, these reasons come back to the cyclical market that exports are supposed to cure. Unable to gear up and maintain a steady rate of production, firms find that when orders pick up, a backlog develops: "When delivery dates run 16 months or longer behind orders, foreign sales are undermined and import purchases among customers at home are encouraged." Like Sisyphus who was ever doomed to push the same rock up a hill, only to watch it roll back down, the machine-tool industry is trapped by cycles of great demand followed by long silences.

The NAE suggests a number of roads out of this quagmire, all involving indirect subsidies of the industry and initiatives to encourage exports. The suggestions include developing a coherent national export policy, increasing the sensitivity of the Department of Commerce to the needs of small business, altering tax policy to encourage foreign trade, increasing federal support of doctoral candidates in manufacturing-related disciplines, and increasing federal support for research and development.

However, Pollock is doubtful: "The problem with the [NAE] study is that the data they used are not current." Given the disastrous state of the industry, the NMTBA no longer believes the suggested policies will work. Instead, the industry has asked that imports be restricted to 17 percent of domestic consumption—approximately half of current levels. The industry hopes that this protection will push the rock to the top of the hill and get machine-tool builders onto firm ground.—*Frank Lowenstein* □



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way to "bolster the economy," and the Kennedy administration invoked it as a way to "get America moving again." High bids and cost overruns became the norm. For example, by 1981 the cost overrun of the Army's XM-1 heavy tank program exceeded $13 billion. By 1980, prices of military goods produced by the network of 37,000 defense contractors and their 100,000 subcontractors were rising an average of 20 percent a year, according to the Defense Science Board, a panel of technical experts assembled by the Defense Department.

Thus, cost-maximizing (within the limits of subsidy) has replaced cost-minimizing among the prime military-serving firms, including the most advanced segments of the machine-tool industry. The Pentagon's prime contractors purchase advanced machine tools to manufacture aerospace and other military goods. And the Pentagon itself is probably the largest owner of machine tools in the United States. According to a letter sent to me from the Defense Industrial Resources Support Office within the Department of Defense, in 1981 the DOD owned 103,000 machine tools, worth over $1.7 billion, used by contracting firms and their subcontractors. For example, the so-called Lockheed plant in Marietta, Ga., which produces the C5A transport aircraft, is government property—land, buildings, and machinery. What Lockheed sells is a management service. In addition to machine tools used by contractors, the Pentagon maintains "plant equipment packages"—packages of machine tools ready to produce particular military goods—and a "general reserve" of assorted machine tools.

The machine tools owned by the DOD and military contractors are often the most advanced available, designed and built by blue-chip firms. Thus, the handful of firms that have done the most to advance numerically controlled machine-tool technology enjoy a close relationship with the military.

Though there are no figures to quantify the extent of this relationship, one can often see advanced military-production tools being made in the leading machine-tool firms. The main plant of one well-known firm that I once visited was devoted to constructing numerically controlled "elephant tools" for shaping workpieces over six feet in diameter—undoubtedly for missiles. In another plant a former student showed me two kindred machine tools: one hand-lever-controlled for export; and one loaded

In 1978 the U.S. machine-tool stock was devastatingly old: virtually the same age as in 1940, after 10 years of the Great Depression.

with electronic, hydraulic, and mechanical controls—and costing four times as much—for the air force.

The close connection between the military and the machine-tool industry has had unfortunate results. In developing advanced machine tools, firms were able to avoid the hard work of keeping costs down through efficient design and production. A two-and-a-half-year study completed in 1980, sponsored by the air force's Wright Field research establishment and the Lawrence Livermore National Laboratory, marshalled researchers from U.S., European, and Japanese universities to define new goals in designing and using machine tools. Entirely missing from the five volumes of technical papers was any reference to efficient organization of production in the machine-tool industry itself. Everyone participating in the study apparently assumed that production is in good order—and for the air force, it probably is.

But from the standpoint of the nation's stake in improved productivity, this approach is flawed. Heavily influenced by military sponsorship, advanced numerically controlled machine tools have been so expensive as to be out of reach of most U.S. metal-working firms. In 1979, after the technology had been available for more than 20 years and had been heavily promoted in the trade press, only 2 percent of all the machine tools in use in this country were numerically controlled.

Even in the production of less advanced machine tools, the industry's traditional pattern of cost-minimizing has been inverted, marking the end of an industrial era. U.S. machine-tool prices rose an average of 85 percent from 1971 to 1978, while hourly industrial earnings increased 72 percent, according to the U.S. Bureau of Labor Statistics. By contrast, machine-tool prices rose only 51 percent in Japan during the same years, while average hourly wages grew 177 percent, according to The Bank of Japan. Japanese managers performed in exactly the cost-minimizing manner that was once the U.S. tradition.

U.S. industry did not automatically respond by purchasing foreign-made machine tools. Managers are leery of buying equipment of unknown quality, and they value a vendor who is near enough to service the equipment—it can be very costly when machines are down. A move to purchase machinery abroad requires more than cost savings.

As a result, U.S. managers first responded to increased prices of machine tools simply by not buying new ones. According to the National Machine Tool Builders Association's *Economic Handbook of the Machine Tool Industry*, by 1978 only 31 percent of U.S. machine tools were less than 10 years old. In West Germany the figure was 37 percent, and in Japan it was 61 percent.

That same year the editors of *American Machinist* made a devastating observation: the age of the U.S. machine-tool stock was virtually identical with what it had been in 1940, after ten years of the Great Depression, a period of scant capital investment. However, the failure of manufacturers serving civilian markets to replace equipment in the 1960s and 1970s was largely a result of high machinery prices, not of a classic business depression.

Aging U.S. production equipment, in turn, contributed to the falling rate of productivity growth in U.S. manufacturing after 1965. From 1965 to 1975, the average annual rates of improvements in manufacturing productivity were 10 percent in Japan, 5 percent in West Germany, and 2 percent in the United States. In 1980 U.S. productivity declined by 0.5 percent—an unprecedented stagnation. Since 1965 the United States has had the lowest rate of productivity growth in any industrialized country.

Making Money, Not Machines

There is no evidence to suggest that managers of the U.S. machine-tool industry planned these effects by seeking out military sales, or that Pentagon officials deliberately undermined U.S. industry. The machine-tool firms simply followed accepted methods of maximizing their profits. Like many other U.S. firms, they were overly concerned with quarterly financial figures. There are large fluctuations in the U.S. machine-tool market, and managers sought to protect their firms against these. These companies diversified into other businesses, such as manufacturing machinery for making textiles and building roads, and they entered into a variety of foreign arrangements. These included not only investing in factories but also licensing patents and providing blueprints.

The editors of *American Machinist* have compiled unpublished reports on these foreign arrangements. The first listing, in 1966, filled 10 typed pages and indicated that such foreign arrangements were already a significant factor in the machine-tool industry. The 1974 tabulation filled 30 pages and the 1981 roster, still incomplete, will exceed 40 pages. The dol-

Half the machine tools offered by one major U.S. firm are built abroad. The company is well on its way toward terminating production and focusing on marketing.

lar value of these overseas arrangements is not generally known, but an unreleased 1972 report by the U.S. Commerce Department revealed that overseas factories of U.S. machine tool firms had sales of $450 million in Western Europe alone.

As the top managers of the U.S. machine-tool industry began investing abroad and diversifying into other businesses, they became less concerned about the long-term productivity of their U.S factories. They sought out defense orders and tariff protection to sustain their businesses. They tended to avoid costly five-to-ten-year investments in production equipment that would have appeared as expensive overhead during the periodic slumps endemic to the U.S. machine-tool market. Thus, the very industry that developed advanced numerically controlled machine tools has itself installed very few of them. By 1978 only 3.7 percent of the metalworking equipment used in the machine-tool industry was numerically controlled, according to the NMTBA. That record is little better than the 2 percent of tools that are numerically controlled in industry as a whole.

Furthermore, managers of U.S. machine-tool firms that do employ numerically controlled equipment often do not organize production effectively. When a machine tool is worth a third of a million dollars, its productivity becomes extremely important. To ensure that a numerically controlled machine tool produces at a stable and high rate, the operator must know how to maintain the tool and adjust its computer program—in short, must intervene whenever there are malfunctions. When I visited the Yamazaki machine-tool plant in Japan in 1979, I found that this principle was fully understood. Machinists were taught computer skills, and management delegated the necessary authority.

This is hardly the general view managers in the U.S. machine-tool industry hold of how to organize production. Following the teachings of Frederick W. Taylor, the early twentieth-century proponent of "scientific" factory management, U.S. managers have often used numerically controlled tools as a way to subdivide and simplify production tasks while lowering machinists' job ratings. For example, according to a poll taken at a meeting of the International Association of Machinists, when numerically controlled machines malfunction, machinists are frequently allowed only to flick the off switch and wait—often a long time—until an engineer or technician arrives.

Management's attempt to use numerical control to broaden its own control and downgrade workers' jobs has not only wasted the abilities of skilled machinists; it has also resulted in strikes, bitter feelings, and underutilization of costly equipment. Thus, it is hardly surprising that numerically controlled machines have gained narrow acceptance in the U.S. machine-tool industry.

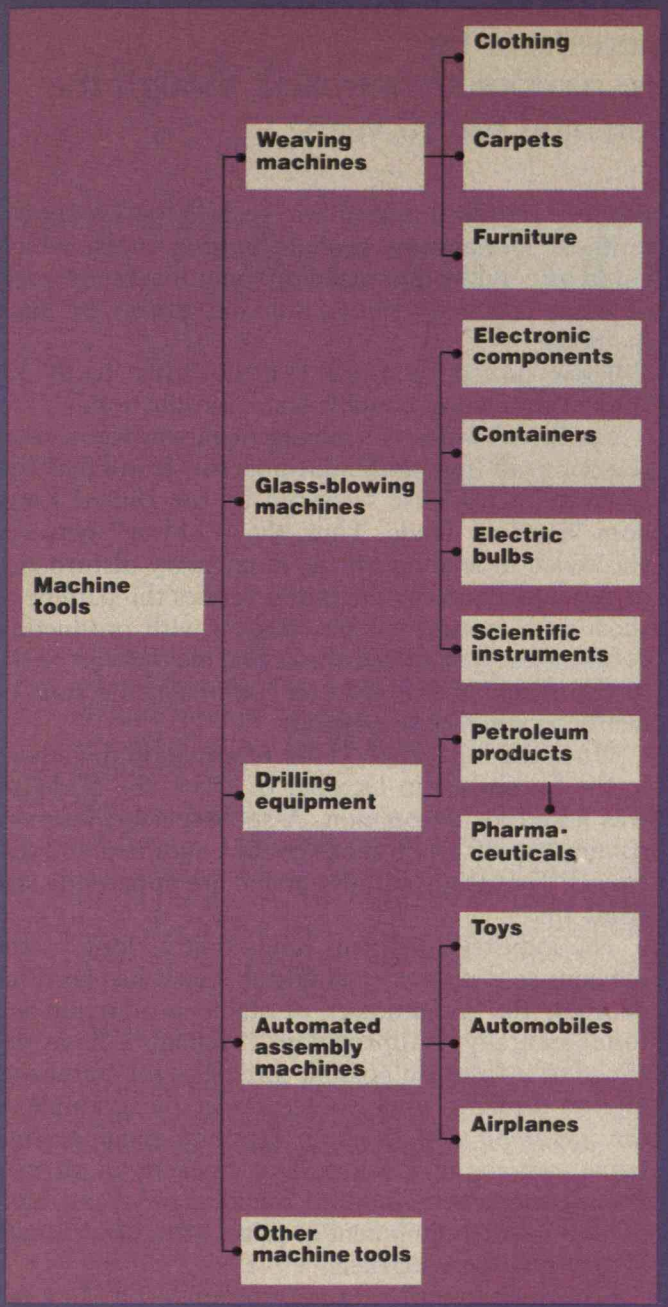
The situation in Japan and some European factories is quite the opposite. In December 1979 and February 1980 I observed advanced machine-tool factories under construction in Budapest, Hungary, and Nagoya, Japan. Not only are the individual pieces of machinery numerically controlled, but entire plants are coordinated by computers.

Another crucial matter that the U.S. machine-tool industry has generally overlooked is the need for stable production. Stable factory operations—rather than mere numbers of products—form the true basis for the advances made through "mass production." Yet ironically, most U.S. machine-tool firms have not adopted such operations. At the International Machine Tool Show in Chicago in September 1980, I asked what size lots a large U.S. machine-tool maker produced. "Well, you don't produce a $350,000 machine for inventory," the sales manager answered. "When you order one, we make it."

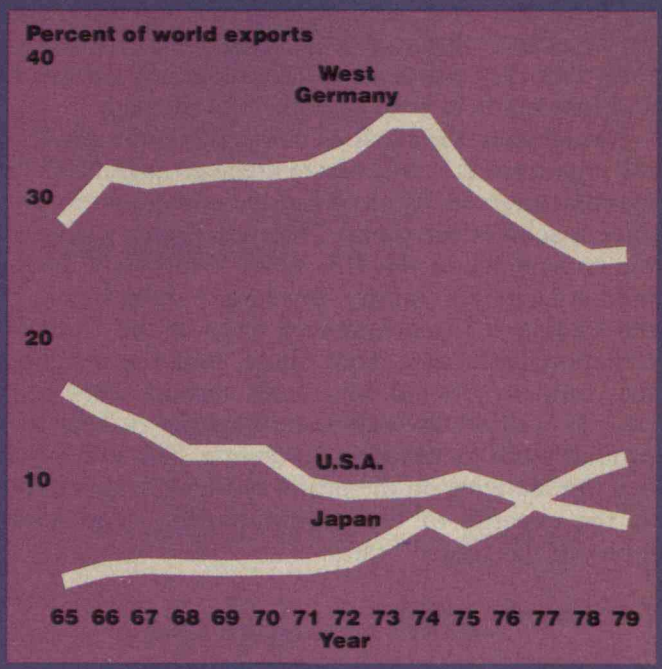
U.S. firms have not risked investing in plant machinery to produce at a steady rate for reasonable prices. Instead, they have kept capital investments low and used manual production methods so they can economically cut back during slack periods. In the name of spreading around the risk, individual firms have made a wide variety of tools, from lathes to milling machines, rather than honing research, development, and production on a specialty. Vendors boast of making "custom-built" tools, yet that way they have no clear market with set prices.

By contrast, at the same machine-tool show, one of the smaller Japanese firms, employing only 100 workers, disclosed that it was producing numerically controlled machine tools at the remarkably high rate of 30 units a month. With steady production, a representative explained, it is possible to buy components from suppliers on a predictable schedule at good prices. Japanese machine-tool manufacturers count on attractive prices and high quality to enable them to sell to a worldwide market and dampen periodic fluctuations in demand. Japanese firms can produce advanced machining centers at prices averaging 40 percent below comparable U.S.-produced equipment.

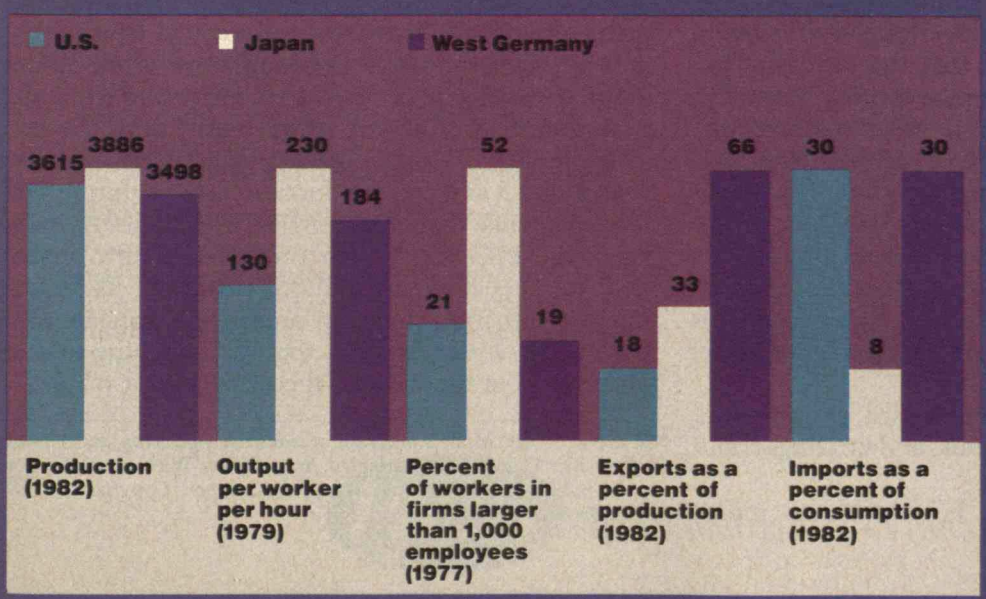
DIAGRAMS: OMNIGRAPHICS



Machine tools, an important factor in U.S. industrial and economic strength, are used to manufacture almost all the products on which our standard of living depends.



World trade can provide an important buffer against downturns in domestic demand. While the U.S. machine-tool industry has become dependent on variable domestic markets, the Japanese industry has sought a more stable world market.



The small size of many U.S. machine-tool firms constrains research and development and makes loans for modernization difficult to obtain, resulting in low productivity. High levels of exports have helped Japan and West Germany modernize their facilities and increase productivity.

In 1979 only 2 percent of the machine tools used in this country were computer-controlled, though the technology had been promoted for 20 years.

The stable-production strategy is clearly superior in the long run, while the unstable, one-at-a-time, even ten-at-a-time, output of U.S. machine-tool firms assures that they will remain technologically backward and lose markets both at home and abroad.

Recognizing their loss of competitiveness, some of the important U.S. firms have made arrangements for manufacturers in Western Europe and Japan to produce machines for them. These machines will carry the nameplates of the U.S. firms, which will do the marketing in this country. In a large exhibit by one of the leading U.S. machine-tool firms at the 1980 International Machine Tool Show, half the machines the company offered were built abroad. That company is well on its way to terminating its role as a producer and focusing on marketing. This may result in a fine showing on the profit-and-loss statement but at the expense of less manufacturing—and fewer jobs—in the United States.

Following the British

This basic pattern has occurred before—in the machine-tool industry of Great Britain. Its managers had created a successful manufacturing tradition, but after World War II the industry adopted strategies best suited for making money rather than machines. By 1980 more than 65 percent of England's new machine tools were imported. Alfred Herbert Ltd., the flagship firm of British industry, sustained by government subsidies for a decade, went bankrupt in 1983. That decline contributed to a loss of production competence throughout Britain.

In 1959 I reported to the European Productivity Agency (a predecessor of the Organization for Economic Cooperation and Development) on looming productivity problems in the Western European machine-tool industry. I said that the industry that produced the tools of mass production was not using that stable mode of operations in its own plants, just as the U.S. industry now is not. Compared with, say, automobile manufacturers, machine-tool firms will undoubtedly always make small numbers of sophisticated products. Yet the companies could standardize components to a significant extent, thereby helping to stabilize production. To do so, the European firms needed certain information. I prepared a set of about 15 queries. For example:

☐ What proportion of machine-tool components such as gears, shafts, hand wheels, and bearings could be standardized?

☐ To what extent would it be feasible to mass-produce standard assemblies, such as power-supply units or mechanisms to hold cutting tools, which could be combined to make different machine tools?

☐ What cost reductions could be gained by such methods?

☐ How could demand for machine tools be stabilized, making possible stable production?

The British industry's management was vigorous in rejecting all recommendations for standardizing products, a response seconded by the United Kingdom Board of Trade. Thus, the "old-boy" network succeeded in fending off the momentary disturbance to the status quo. By the mid-seventies the pattern of short-term money-making coupled with production deficiencies had run its course. The major firms of the British machine-tool industry had reached a state of nearly terminal deterioration.

When the *New York Times* reported on my advice to the Europeans in October of 1959, the NMTBA was asked for an opinion. A spokesperson reserved comment until the findings could be studied and discussed. That study and discussion are apparently still going on.

The industry consensus holds that as long as the machine-tool market is as unstable as it has been for decades, the technologies of stable production are fundamentally inappropriate. Managers have declined to investigate possible strategies for stabilizing market demand. They could ponder the example of the Japanese and Western German machine-tool firms, which have learned to operate in diverse foreign markets to smooth out demand—and have offered quality equipment at prices attractive enough to generate these markets.

Economic revitilization programs—be they socialist nationalization of industry, liberal industrial policies, or conservative advocacy of the free market—generally look to broad issues while assuming that management has the incentive and capability to organize production competently. But the core problem may lie with management itself. Workers with a direct stake in production have no future with managements that abandon or neglect it. As management seeks short-term profits, invests overseas, and markets foreign-produced products, its lack of interest and competence in production appears to be the critical issue—both in the vital machine-tool industry and in the industrial economy as a whole.

SEYMOUR MELMAN is professor of industrial engineering at Columbia University. *This article is adapted from* Profits Without Production, *to be published by Alfred A. Knopf in October.*

Are any of your relatives diabetic?

There's a chance you are, too!

If anyone in your family has a history of diabetes—even a distant relative—treat it as a symptom! It should prompt you to have regular checkups because you are at greater risk of having the disease. Especially if you are overweight and over 40.

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Diabetes is a disorder in which the body cannot control the levels of sugar in the blood. Normally the hormone, insulin, regulates the blood sugar level. But if your body does not produce or effectively use its insulin, diabetes results. Diabetes can threaten heart, vision, brain, kidneys and life itself.

What can be done about diabetes?
Often people don't realize that most diabetes can be easily managed by simple programs that bring blood sugar under control. Many diabetics need only weight reduction, the right foods and moderate exercise. And, if these changes are not enough, a simple oral medication is all that may be needed. Today, even those who need insulin can be better and more comfortably managed by their doctors than ever before.

Who has diabetes?
You'd be surprised at how many of your friends and fellow workers are diabetic yet lead full lives with no outward signs of illness. Even many famous athletes and celebrities have diabetes. With current therapy diabetics can usually lead a normal life with simple and sensible medical programs.

What are the symptoms of diabetes?
Warning signs are either absent or very subtle. You may drink more water than normal or urinate more frequently. There may be slower healing of bruises, cuts and infections, or you may experience more fatigue and feel "not quite right."

How will you know if you have diabetes?
You won't. Your doctor will. And again, if there is diabetes in your family—including cousins, aunts, uncles, brothers and sisters and especially a parent—then you should have regular blood and urine checks by your doctor. It is a relatively simple diagnosis.

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Quest for the America's Cup

BY JOHN STANSELL

New technology looms large when a few seconds can mean victory in this historic 24-mile race. Some of the features of these world-class yachts will find their way into boats that recreational sailors take to sea.

YACHTING syndicates from seven nations have spent over $50 million to win the America's Cup, a sailing race between tradition-bound boats that few people sail. The international rules governing these "12-meter yachts" are so tight that most of the boats look and perform nearly the same. However, yacht designers have taken advantage of the freedoms they do have to create astonishing racing craft that influence the rest of the sailing world. In short, what the America's Cup boats have this year will be on top production racing and cruising boats by the next competition. Of course, by then the new generation of 12-meter yachts will be even further advanced.

The race, held in mid-September off Newport, R.I., has been won by U.S. boats since 1851—longest running streak in sports history. But this year a change in the rules put the challengers on more equal footing. Previously, yachts could use only those materials and equipment produced by the country they came from—for example, a British ship was restricted to British technology. This year foreign teams were free to use whatever technology they wanted, and in essence this made available U.S. advances in fields such as electronics and sail design.

While the outcome depends largely on something that technology cannot provide—sailing skill—the role of technology is to give every skipper every possible advantage.

Searching for the Perfect Boat

What freedoms do the designers have? "Twelve meters" is not the boat's length, but the result of a complex equation that defines the entire configuration of hull and rigging—hull shape, sail size, mast profile, and so on. A change in one area must somehow be balanced by a change somewhere else—all within a host of restrictions, penalties, bonuses, and measurement instructions. All serious contestants experiment with hull designs, to the best their pocketbooks allow. They are looking for the "perfect" boat; in practice, that means combining straight-line speed with the ability to corner fast.

One of the most famous innovative boats was *Intrepid*, designed by Olin Stephens, who once said, "There is no such thing as a 'breakthrough' yacht." The essence of advancement, he said, was the cumulative effort of many people—an inching towards perfection, not a leap. One significant decision with *Intrepid* was to separate her rudder from her keel. The yacht's success in 1967, albeit against an indifferent Australian boat, led this hull form—called the "fin and skeg"—to become the dominant shape for racers and cruisers alike ever since.

Intrepid also had other new wrinkles. The winches for controlling the sails, as well as the crew members who wound them (called "grinders"), were moved below deck, and the boom was lowered to about half its traditional height above the deck. Halsey Herreshoff, a naval architect and grandson of the respected designer of America's Cup yachts in the early 1900s, had experimented with the lower boom at M.I.T., and demonstrated that it greatly improved the mainsail's performance. The concept was later banned and the grinders returned to the deck, but the technology was proven.

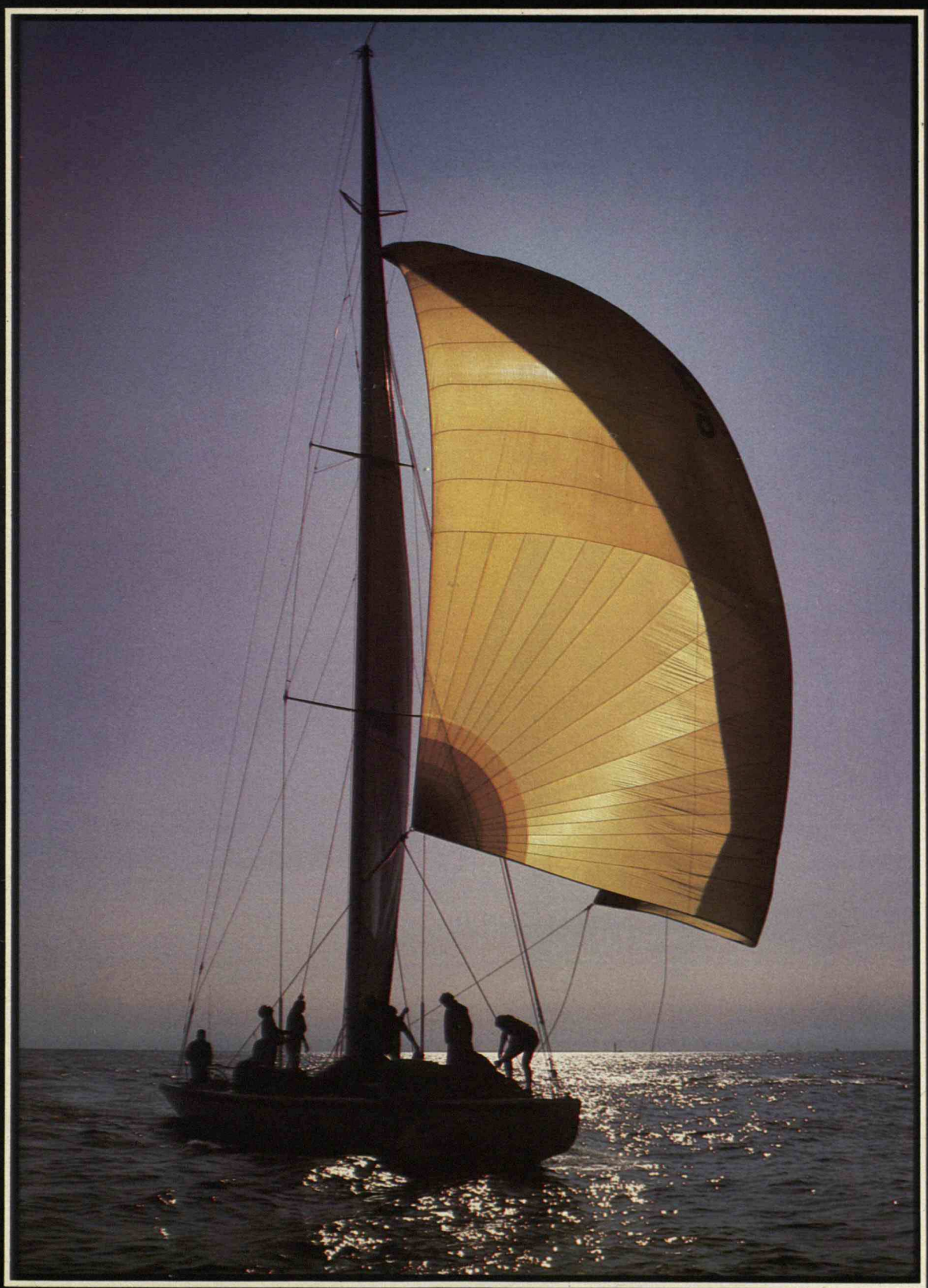
This year, the Australians produced the most exciting and controversial new technical change—a radical keel design aimed at making this yacht, *Australia II*, more maneuverable and faster in tacking. The creation of Ben Lexcen, who also helped design the 1980 Australian challenger, the novel keel is relatively small and has a concave leading edge that rakes slightly forward at the bottom toward a torpedo-shaped bulge—rather like the bulbous bow of a tanker. Two small fins sprout from the bulge and point slightly downward, and a rotating "trim tab" at the rear of the keel (which helps steer) gives twice as much leverage as the conventional tab on 12-meter yachts. Actually, details are still somewhat sketchy, since the Australian team has kept the keel covered when the yacht wasn't in the water.

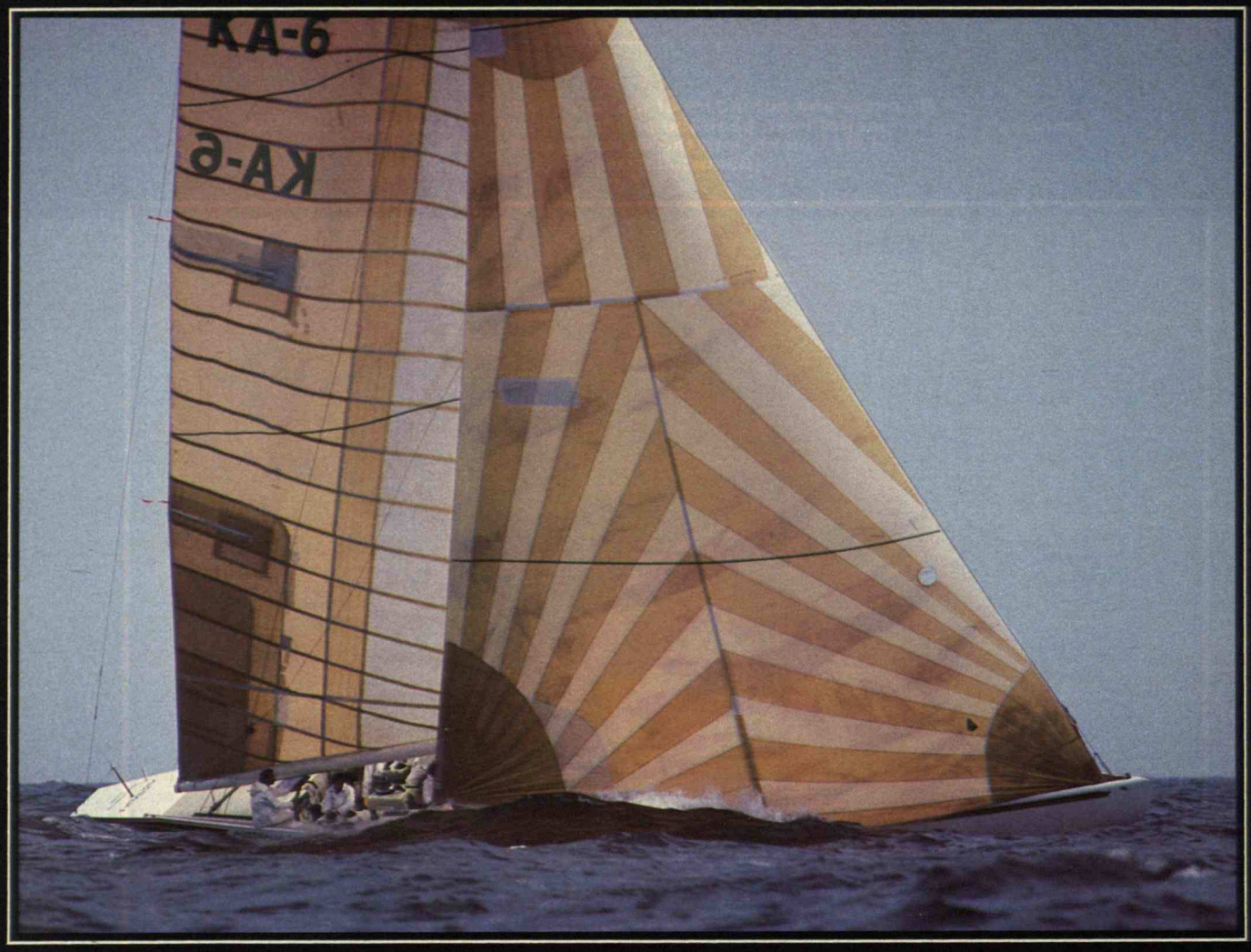
The outstanding performance of *Australia II* in early trials clearly worried some of the other syndicates as well as the New York Yacht Club, which administers the competition. Indeed, the club claimed that the keel (or what it knew about the keel anyway) had peculiarities that gave the yacht an unfair advantage and therefore violated the rules. The International Yacht Racing Union, which oversees such matters, measured the boat for a third time and gave it a clean bill of health. As this is written, it appears that this keel could be the key to the America's Cup going to Perth in September.

JOHN STANSELL is a British freelance writer specializing in science and technology.

PHOTO, RIGHT: FRANK SITEMAN

Challengers and defenders of the New York Yacht Club's America's Cup (opposite) have been the proving ground for technology that has moved quickly into the world's yacht basins.
(Below: *Australia II*)





Sails have been a fertile ground for new technology on the America's Cup fleets. Because of its resistance to stretching, Dacron was pioneered as a sail material in 1958, followed by Mylar and then (1980) by Mylar/Kevlar "polyknits." But the stiffness that makes these new synthetics so desirable aloft makes them less than friendly on deck.

(Above, *Australia II*: right, *France III* and *Liberty*)

Enter the Synthetics

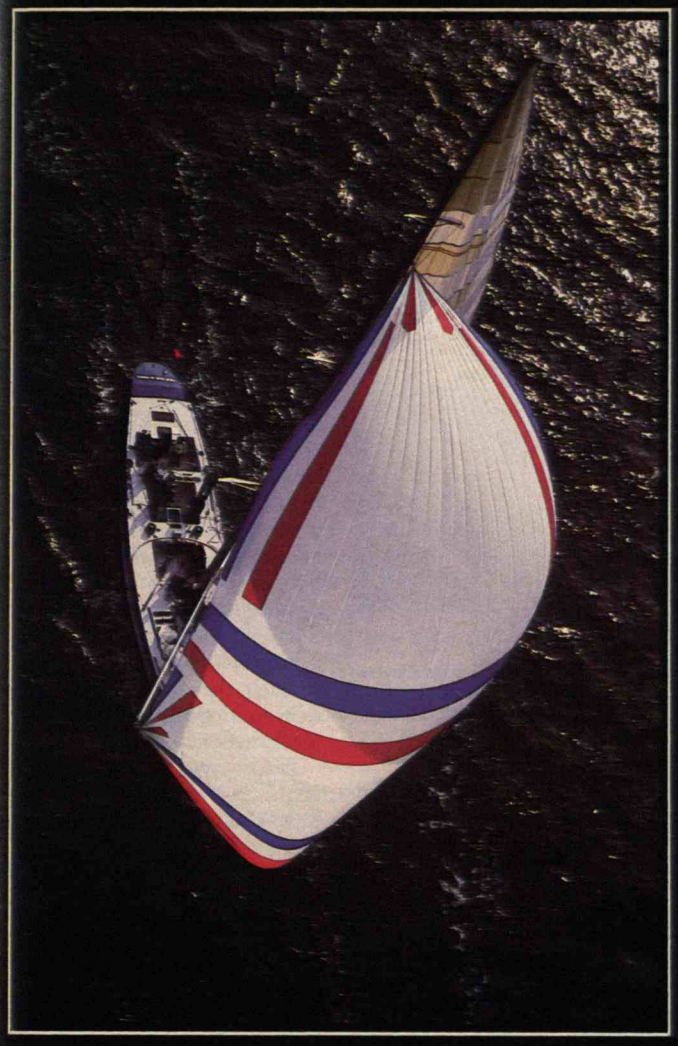
But no matter how fancy the keel, a 12-meter yacht can't succeed without top quality sails, rigging, and electronics. Indeed, sails have perhaps the highest technology content of any part of these anachronistic racers. When the boat is going into the wind, the sail acts as an airfoil. A partial vacuum builds up in front of the sail—as it does above an airplane's wing—moving the boat forward. When the boat heads downwind, the wind simply collects in the sails and pushes. The yachts have many cuts of sails, each of which functions better in different wind and sea conditions. But the secret of any good sail is maintaining its intended shape, and new materials have led to critical improvements.

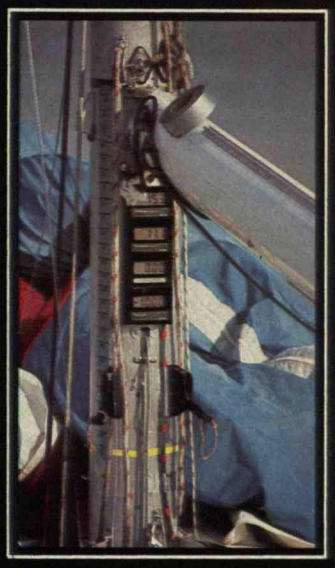
Once, the best sails were made from Egyptian cotton, but they stretched quickly and were damaged by sunlight. Then in 1958 a boat named *Vim*, designed by Olin Stephens in 1939 and resurrected by shipping magnate John Matthews, entered the lists for the America's Cup competition, the first match since the war. Among the crew was Ted Hood, who brought sails made of Dacron to the competition for the first time. Sailcloth woven from the synthetic fiber proved to be more stable and durable than cotton. The early Dacron sails stretched less, but they still stretched too much, until sailmakers learned the art of tempering the cloth by heat treatment, and later by applying surface coatings of resins.

After that, Dacron swept the sailing world. Nowadays only the most traditional of wooden yachts—and the most advanced racers, it turns out—use anything other than Dacron, a direct spin-off from the America's Cup. The new sailcloth was also the making of Ted Hood. For two decades his sails helped American 12-meter yachts to successfully defend the Cup and took his company to the top in all forms of sail making.

Then came another innovation. In the 1970s, sailmakers seeking materials that stretched even less than Dacron began to experiment with a plastic called Mylar. Mylar is very tough, but will tear in a flash

PHOTOGRAPH: ROBERT D. HAGAN





The lowly winch is an object of high technology—as well as brute force, during a race—aboard America's Cup yachts. The goal is to translate the effort of the "grinders" (two on each winch) with highest efficiency, a marriage between strength and precision. Computers enter this arena, too: the stress on the halyards is displayed at the base of the mast.

(Lower right: *France III* (left) and *Canada I*)

if put under too much load or snagged on a sharp projection. So sailmakers gave it "tear strength" by glueing a fabric to it. Sails made in this two-ply fashion—Mylar glued to a cloth made of Dacron or polyester—made their debut on several boats in the America's Cup in 1977. Indeed, new sails gave the U.S. defender, *Courageous*, an important advantage against Australia.

Mylar sails have now spread into ocean-racing yachts and to the top end of the cruising market—large charter boats and so-called "cruiser-racers." However, sailmakers still weren't satisfied, because the sails would stretch as they got older, so they turned to yet another synthetic fiber, Kevlar. Known for its use in composite aircraft components, Kevlar is both very strong and very light. To make the new sails, Kevlar fibers are woven together with polyester or Dacron fibers, and the composite cloth is glued to sheets of Mylar.

Mylar/Kevlar sails were first used on *Freedom*, helping her to victory in the 1980 Cup competition. As the advantages of such sails became known, the ocean racing fleet took to them eagerly. They are very stiff, which is just what is wanted. The stiffness produces a firm shape that does not change over a wide range of wind speeds. But Mylar/Kevlar sails were then (and still are) very difficult to handle.

That disadvantage was not too important to the racers because of the vastly increased performance, but there was another snag. It is very difficult to glue Kevlar to anything, and some of the Mylar/Kevlar sails failed dramatically. Sailmakers went back to the drawing board to find out why. What happens, they discovered, is that the ultraviolet rays in sunlight harden the glue progressively until it becomes like a sheet of glass. When it has been bent once too often, the glue in the sail shatters into tiny slivers, literally blowing the sail up. The only way around this was to use better glue. But what? The search is still going on, with the leading makers of sailcloth devoting considerable resources to the problem. The subject is so vital that these firms won't reveal what glues they use now or are working on.

PHOTOGRAPHS: ROBERT D. HAGAN, J. H. PETERSON

Computers at Sea

BY TONY CHAMBERLAIN

NEWPORT, R.I.—A bumper sticker for yachting traditionalists in these parts reads: "If God had wanted aluminum boats, He would have planted aluminum trees."

Richard McCurdy, an engineer who develops marine electronics, takes it a step further: "Actually," he says, "we all know that God also prefers wood to fiberglass and cotton over Dacron sails—certainly over Mylar."

If this is true, McCurdy concedes, then the deity must be horrified at what is happening on the America's Cup 12-meter racing yachts these days. In a word—computers. Computers that help shape hulls and pattern sails into the most efficient wings. And perhaps the most towering irreverence wrought by high-tech is the use of computers to sail boats faster.

Less than a decade ago, in the 1974 cup race, the notion of getting navigational instructions from an on-board computer was little more than a dream of McCurdy's, who installed some relatively simple electronics on the 12-meter yacht *Valiant*. By 1980 the idea had grown to a $60,000 system of shore-side and on-board computers for *Clipper* that could actually tell the skipper why he was losing ground and time, and how to correct the boat's position.

This year, what many call the most elaborate computer system ever will be hooked up to *Defender*, a boat designed by David Pedrick, a naval architect in Newport, and equipped by McCurdy. The on-board system is attached to instruments that monitor boat speed, wind speed, wind angle, heel angle (how far over the boat is leaning), compass heading, and elapsed time.

Computers are ubiquitous, afloat and ashore, among America's Cup entrants, improving their crews' understanding of their own performance as well as their skippers' view of strategy. Top: the cockpit—readouts everywhere—of *Challenge 12*; below: skipper's console on *Australia II*.

Today even very simple racing boats monitor these data, called "lay-line" information. However, *Defender*'s computer is able to meld all the data together to find the "dead reckoning"—the path showing precisely where the boat has sailed relative to the mark she is headed for. "Then," says Pedrick, "the computer can tell you what you need to do to get there as fast as you can. It figures all that out and gives you updates twice a second."

If the sailors will listen, that is. Before all this, sailors mixed raw information with instinct or educated guesswork. Now, even though there isn't exactly a campaign against computerized sailing, "there is enough skepticism so that a lot of sailors don't use what is available," says McCurdy.

Also, adds Pedrick, getting a sailboat through the elements as fast as possible is so complicated that there is a real possibility for major error if the skipper is not an expert at using the computer. The alternative is to give up some of the command to a person who is adept at the computer—a somewhat heretical concept.

Computers demonstrated some of what they have to offer in the last America's Cup competition. In 1980, when most competitors had limited computer aid to monitor weather and sea conditions, *Clipper* was able to make electronic pictures of the actual path it was sailing.

"You first have to understand how hard it is in a boat to know exactly where you are," says Pedrick. "That is, whether you're close to the approach line to one of the course marks or straying off it." A boat that moves off course even slightly loses valuable seconds, he says: a one-minute lead in a three-hour race is considered a comfortable margin.

"We had one particularly enlightening day on *Clipper*," says Pedrick. "*Clipper* and *Freedom* (her U.S. competitor) had a tacking duel [wherein one boat, turning from side to side through the wind, tries to force the other boat to lose position]. As the two boats were converging on the tacks that brought them together, the helmsman got nervous and turned toward the wind too soon, slowing down long before he made his tack."

Before the computer age, such an observation would have been impossible. But by analyzing the thousands of bits of performance data collected by the shore-side computer, McCurdy and Pedrick were actually able to see the errors *Clipper*'s crew was making.

Pedrick, an experienced ocean sailor, believes that as the computer systems designed for the 12-meter boats become standard equipment for all racing yachts, popular acceptance of computerized racing will follow. "What people will come to realize is that computers just don't know how to sail. They can't steer a boat, they can't take a look at a sail and decide if it looks good or not. People still have to sail. That's still the important factor of the sport.

"All the computer does," he says, "is give the human beings, who are trying to make the boat go as fast as it can, a lot more and faster information about whether they are succeeding."

TONY CHAMBERLAIN is a staff writer for the Boston Globe. *This is adapted, with permission, from the* Globe.

PHOTOGRAPHS: GRACE TROFA

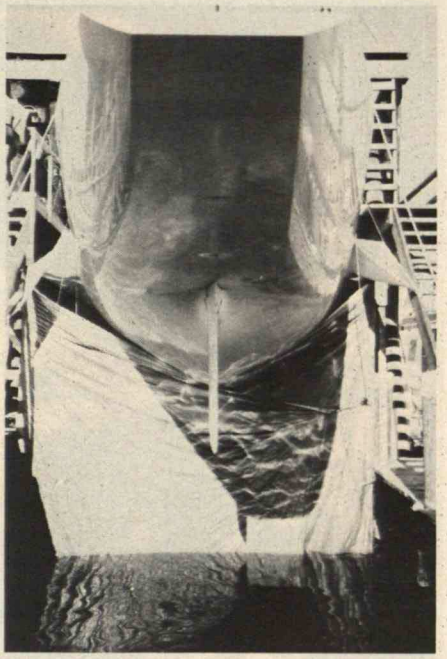
Though Mylar/Kevlar's cost and difficulty of handling make it unlikely to become a favorite with cruising sailors in the foreseeable future, its progress continues in the racing world. The latest advance is called "warp Kevlar," in which the Kevlar fibers are oriented lengthwise in the bolt of sailcloth to provide even more strength.

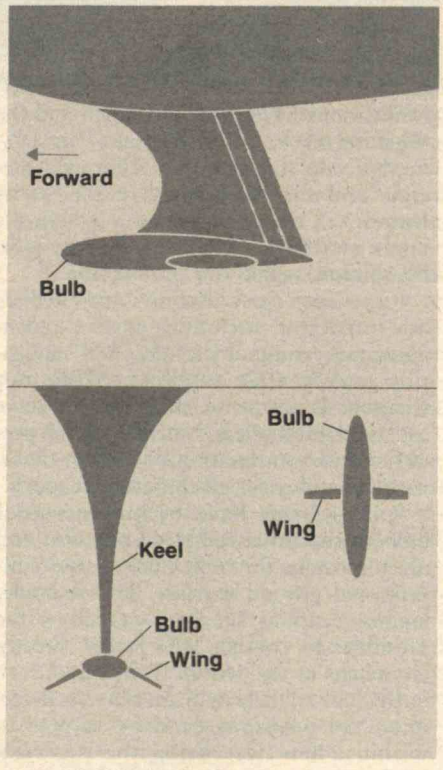
The manufacturing process is something of a technological feat. The bolts must be made long; economics dictate that manufacturers won't start their looms for only limited runs. Normal lengths are at least several thousand yards, and for a bolt of sailcloth about 5,000 Kevlar fibers of this length are needed. Each fiber must be extruded—at a rate of only three inches a minute—and any break makes the entire fiber worthless. The warp Kevlar made for this year's competition, which became available in March, was made in a bolt 5,000 yards long and cost $100,000. Small wonder that a warp Kevlar mainsail can cost up to $15,000.

In 1977, there was another change in sailmaking that has passed from the America's Cup to racers and then cruisers. It is called the leech-cut sail. Traditionally, sails have been made by stitching panels together horizontally, forming what are known as "cross-cut" sails. But the main loads on a sail are vertical, so they exert tremendous force on the seams.

Tom Schnackenberg, who works for North Sails in Australia, had already made his mark by designing a computer program to transfer a sail designer's plans into cutting instructions. He reprogrammed his machine to cut the sails with vertical panels. With the load being taken by the cloth and not the seams, the sail could be lighter. Sails with vertical panels also proved to retain their shape over a wider range of wind speeds. For the racer, that saves time because sails needn't be changed as often. For the cruiser, it means the boat can safely carry one sail longer, as the wind increases. But fashion is having an impact here; while leech-cut sails are growing in popularity with cruisers, top racing crews are turning back to cross-cut sails.

The reason, they say, is that the horizontal panels make the sail "easier to read" when trying to squeeze that extra tenth of a knot out of the boat. So the sailmakers went back to their drawing boards once again, and have come up with "the spider." Put simply, a spider-cut sail uses vertical panels, so that the loads are in the right direction, but the panels are also sewn horizontally so the stitching keeps the crews happy. The result is a sail with seams in a grid form that resembles a web; hence the term "spider." It is said to be a fast sail, but is probably too new for America's Cup crews to risk using it yet. All the signs are that the finals in September will be won and lost with cross-cut sails.





***Australia II*'s radical keel was carefully shrouded (above), but it was known to involve "wings" (below) to give increased draft, hence greater stability, when heeled in the wind.**

Of Winches and Computers

"If the sails of a 12-meter are equivalent to the engine of a Grand Prix race car, then its winches are the controls," says Phil Atfield, an engineer with Lewmar, a British firm that has installed winches on most of the America's Cup boats in Newport this year. At first glance, a winch hardly looks like high technology. In essence, it is a concave drum around which you wind a rope that is connected to a sail, thereby allowing the crew to control its position. But given the tremendous pressure on the sails in a stiff wind, with every fraction of a second counting, the winch must deliver high power and high speed.

This calls for a marriage between brute force and precision engineering. Facing each other, two crew members turn the cranks that deliver rotary power to the winch drums through automatic gearboxes, chain drives, and universal joints borrowed from helicopters. In designing the winches, the engineers at Lewmar measured the loads under various conditions and arrived at designs using modern construction materials. Indeed, the materials used to build this humble unit would not disgrace a modern fighter plane.

The winches are only half as heavy as most previous models, and work just as well. And the progress that Lewmar made in its winch design for America's Cup boats has gone straight into its other racing and cruising models, which feature needle-roller bearings for minimum friction, nylon chain drives for low weight, stainless steel drums for strength and durability, and high-stress plastics for ball bearings.

Computer versus Skipper

While winches, no matter how sophisticated, may seem right at home on sailboats, the matter of adding computers and

Continued on page 77

PHOTOGRAPH: GRACE TROFA. DIAGRAMS: OMNIGRAPHICS

Space Doctrine, Cornucopians, and Synthetic Fuels

Space Theologians

The New High Ground
by Thomas Karas
Simon and Schuster, 1983

Reviewed by Gerald Steinberg

In his "Star Wars" speech earlier this year, President Reagan endorsed the development of a space-based system of "anti-missile missiles" and lasers to defend the United States against Soviet attack. However, while advertised as an entirely new approach to the problems of strategic nuclear warfare, this plan has a long history. As Thomas Karas writes in *The New High Ground*, such a project has been pursued by the military space establishment for many years.

This establishment consists of the large space and defense contractors such as Rockwell International and Boeing; the military, particularly the air force; and civilians working in the Pentagon on space and satellite programs. Since *Sputnik*, these enthusiasts have been searching for a "space doctrine" that would clearly define a purpose for military activity in space and thus justify establishing an independent branch of the military. Although military communications and reconnaissance satellites have been well funded, the Department of Defense has regarded them as ancillary to earth-based military forces. Given an orbiting defense system, the military's space enthusiasts would finally have the justification for an even larger budget.

Through interviews, Karas documents the efforts of the military space fraternity to increase its influence. Generals and Pentagon officials self-servingly cite the case of Billy Mitchell, an army officer before the Second World War who argued that the military brass had ignored the importance of air power. His claims were disregarded and he was court-marshalled, only to be hailed as a visionary a few years later. Similarly, proponents of an active military presence in space like to portray themselves as scorned prophets whose truth will soon bring salvation.

The high priests of space often present their message in grand theological terms. For example, Colonel Morgan W. Sanborn (ret.), a manager in Rockwell's Space Transportation System Division, manufacturers of the shuttle, argues, "Past

civilizations have risen and fallen and the West seems to be in decline. The U.S. needs to do something to reduce this decline and the ascendancy of the Soviet Union. . . . Space is an area where we might establish new goals, galvanize public opinion, regain our momentum."

Karas does agree that military satellites are important, including passive reconnaissance, communications, and navigation and weather satellites. While not weapons in any sense, these systems serve as "force multipliers," increasing the precision and coordination of planes, tanks, rockets, and other earth-based weapons.

Such systems have become essential links in the entire military operation and are important for both nuclear and conventional ground warfare. For example, communications satellites can allow the president to contact U.S. forces directly anywhere in the world. Tanks and even individual soldiers will be able to determine the positions of their targets to within a few feet using the NAVSTAR Global Positioning System. U.S. "spies in the sky" can count the number of Soviet missiles, and analysts can estimate annual tank production by measuring the floor space of tank-manufacturing plants photographed from space.

But Karas argues that "we also need to understand that space power is not going to provide us with a military superiority that will solve all our problems." In particular, Karas cites many analysts who see the effort to build space-based weapons as merely leading to another pointless arms race.

In fact, this race has already begun in the area of antisatellite weapons. Since 1968, the Soviet Union has been testing a primitive antisatellite system. Although in its current form this project presents little, if any, threat to U.S. military satellites, the supporters of a "space command" claim to see the basis of a future threat. Therefore, the United States is developing its own antisatellite system that would be far more advanced than the Soviet one. Since the Soviets can be expected to respond in kind, an expensive and dangerous competition has already begun. U.S. military space "assets" could actually best be protected by a number of less expensive and more effective measures. For example, duplicate satellites can be placed in separate orbits, so if one is damaged another can take its place.

The Reagan space-based ballistic-missile defense system would be a far more serious extension of the arms race. A laser system would require up to 50 orbiting battle stations with fuel provided by thousands of flights of the shuttle, according to Karas. Furthermore, a variety of countermeasures could nullify the usefulness of the entire trillion-dollar system with relative ease. For example, the missiles could be hardened with a reflective coating, so the lasers would not be able to damage them readily. And given the destructive power of nuclear warheads, the leak of even a few would be disastrous.

While Karas provides a relatively detailed summary of these issues, *The New High Ground* suffers from a number of basic flaws. Most important, the author, a journalist, relies almost exclusively on other sources for information, which limits his ability to make an independent evaluation. He also relies heavily on *Aviation Week and Space Technology* for details on military space systems. However, by consulting the many more analytic studies in this area, he could have been more accurate and analyzed the issues in greater depth.

For example, one of Karas' sources claims that reconnaissance satellites will prevent such "surprises" and "faits accomplis" as the 1968 Soviet invasion of Czechoslovakia. However, U.S. reconnaissance satellites monitored the Soviet buildup, and the invasion came as no surprise to those with access to the satellite data. In fact, many knowledgeable observers think this case illustrates the *political* limitations on using reconnaissance information from space.

The New High Ground would also be much improved by a broader historical perspective on the politics of the space program. For 30 years, the military space establishment has been challenging NASA, a civilian agency, for control of national space programs. During that time, the Pentagon spent billions of dollars on manned space projects such as Dyna-Soar and the Manned Orbiting Laboratory. In each case, sponsors cited the "invaluable" contribution these systems could make toward reducing the "imminent Russian threat." Then, as now, such projects were couched in terms of the theology of salvation from space. But costs increased, the Soviet threat failed to materialize, and the technology was found to be more complicated than advertised, so administrations from both political parties canceled these projects.

Without this essential background, the author cannot tell us what distinguishes the latest proposals from their predecessors. In fact, they may be destined to meet the same fate—the only difference is that the price tag keeps going up. □

Gerald Steinberg teaches science and technology policy at the Hebrew University in Jerusalem. He is the author of "Satellite Reconnaissance" *(Praeger, 1983).*

Material Abundance or Ecological Disaster?

Catastrophe or Cornucopia
by Stephen Cotgrove
John Wiley and Sons, 1982

Reviewed by Scott Paradise

Ten years ago *The Limits to Growth* predicted the collapse of industrial society if its growth continued unchecked. That study, based on computer models constructed in the M.I.T. Systems Dynamic Laboratory, added fuel to the acrimonious debate between industrialists and environmentalists, which has since produced shelves of books, scores of conferences, and hundreds of angry confrontations.

In *Catastrophe or Cornucopia*, English sociologist Stephen Cotgrove attempts to explain why this controversy still stands unresolved. Though Cotgrove has studied the conflict in Britain, his analysis can also help us in the U.S. better understand the problems confronting industrial society.

Cotgrove calls "Catastrophists" those who argue that industrial society cannot continue to grow at the current rate without disaster. Such people regard ecological collapse as inevitable unless society makes fundamental changes in its institutions and commitments. He calls "Cornucopians" those who say that our industrial system can flourish and provide increasing plenty for the foreseeable future without fundamental change. Cornucopians believe that the industrial system is self-correcting—that any adjustments required by changing circumstances will occur through the operation of the market and the advance of technology.

The debate between the two groups is an exercise in noncommunication, with each side accusing the other of irrationality or worse. Cotgrove quotes Lord Rothschild as calling environmentalists eco-maniacs and eco-nuts. Paul Johnson has labeled the ecological lobby as "simply irrational; but irrationality is an enemy of civilized society, and can be, and is, exploited by the politically interested." On the other side, the *Ecologist* has said of the Windscale inquiry into reprocessing of nuclear waste that "reason and truth no longer prevail in Public Inquiries."

Cotgrove holds that this debate does not stem from disagreement about scientific questions or objective facts. Instead, the two sides embrace fundamentally different views about what society ought to be like. What seems to be an argument about numbers is at heart a disagreement about morality.

The Cornucopians give highest priority to material values, regarding increases in production and consumption as good in their own right. Catastrophists, on the other hand, value growth of the individual. They hold that nature is benign and delicately balanced, and that resources cannot be recklessly exploited without courting disaster. Cornucopians accuse Catastrophists of being doom-sayers, elitists, and subversives; Catastrophists regard Cornucopians as fat cats whose vested interests blind them to reality.

To test the protagonists' commitment to the two value systems, Cotgrove sent a questionaire to randomly selected industrialists listed in *Business Who's Who* and *Who's Who of British Engineers,* and to environmentalists who were members of the Conservation Society, Friends of the Earth, and the World Wildlife Fund. The responses revealed that the industrialists are solidly committed to the Cornucopian paradigm. However, the environmentalists broke down into two groups: "nature conservationists" who think that the environment is seriously threatened but who otherwise support the Cornucopian paradigm, and "new environmentalists" who overwhelmingly support the Catastrophist view.

The latter appear to be a truly new ideological group—middle class and well educated but younger, less affluent, and more radical than either the industrialists or the nature conservationists. They tend to work as teachers, social workers, and

ILLUSTRATIONS: YEVGENY YELCHIN

professionals in fields not closely associated with industrial production. Because the new environmentalists rejected the basic values of industrial society at a young age, Cotgrove concludes that their careers did not breed their values but rather their values motivated them to choose certain careers.

The new environmentalists' disenchantment is reinforced by the fact that scientists do not present a united front in support of ever-increasing production. In fact, many scientists are concerned that pro-growth values are promoting a drift toward global disaster. Environmentalists may be willing to concede that the appropriate use of technology could assure the viability of society. Nevertheless, they fear that this will not happen since "a substantial proportion of the total scientific effort is related to production and defense, to the relative neglect of research on environmental impacts."

But if the Catastrophist argument is moral and rational according to its viewpoint, so is the Cornucopian according to its. And when people's values are threatened, it is not unreasonable for them to feel strongly. Thus, dialogue between the sides is not likely to persuade, especially since society has no generally accepted method of weighing economic values against noneconomic ones.

The Cornucopian paradigm is entrenched in society's social, economic, and governmental institutions. For example, both U.S. political parties consider increasing material production the most important social and economic goal. Thus, supporters of the Catastrophist viewpoint are frequently excluded from the decision-making process.

Those committed to the dominant paradigm, regarding any challenge as illegitimate and dangerous, may resort to a variety of subtle forms of repression, including pressures on universities to control "subversive" departments and to stress research that supports the business culture. Those committed to the Catastrophist paradigm, in turn, may believe that society's institutions have lost their legitimacy, and may be driven to violence and sabotage.

Merely because the Cornucopian view stands closer to the seat of power does not assure that it is closer to the truth. Both sides must recognize that their viewpoints are subjective and deserve to be scrutinized. Because society's institutions take the Cornucopian paradigm for granted, that point of view most deserves but is least likely to receive skeptical reappraisal. However, if the Catastrophists turn out to be closer to the truth yet are ignored or repudiated, the result could be disastrous for us all. □

Scott Paradise is an Episcopal chaplain and coordinator of the Technology and Culture Seminar at M.I.T.

Synthetic-Fuel Future

Synthetic Fuels
by Ronald F. Probstein and R. Edwin Hicks
McGraw-Hill, 1982

Reviewed by John P. Longwell

As the spectre of an oil shortage has retreated while prices have stabilized and even decreased, a sense of euphoria has arisen. Ambitious programs to diversify our supply of liquid fuels by manufacturing them from plentiful resources of solids—principally coal and oil shale—have been severely curtailed. The projected cost of these synthetic liquid fuels is substantially higher than that of petroleum today.

The future remains certain, however. The total world petroleum resource is limited, and the ultimate need for a non-petroleum source of liquid fuels is widely accepted. Yet questions remain: Is large-

scale conversion of solids to liquid fuels feasible? How can synfuels help protect us from future embargos?

Synthetic Fuels by Probstein and Hicks discusses current synfuels technologies in detail. The basic methods for converting solids to a variety of liquid products have been around for many years. Germany produced gasoline from coal during World War II, and liquids made by heating oil shale and tar have been available even longer. However, the technology used in these processes was comparatively primitive and not suitable for scaling up to large production rates. Though the techniques have been substantially improved, they still require high capital investment and convert only 40 to 60 percent of the energy in the solids into liquid fuel. In contrast, petroleum refiners convert about 90 percent of the energy in what they mine into useful fuel.

Converting oil shale or tar into refined products such as gasoline, jet fuel, and diesel fuel is 5 to 10 percent more efficient than turning coal into the same products. Thus, most analysts tend to favor oil shale as a source of synthetic fuel. However, methanol derived from coal may ultimately make a more significant contribution to energy supply, as it is an ideal automotive fuel. Internal-combustion engines specially designed to use methanol can be as efficient as diesel engines and have fewer emissions. If cars and trucks were forced to run on fuels from coal, methanol could well be the standard fuel.

Several modern versions of each of the major processes for producing synfuels have been studied in pilot plants, and pioneer commercial plants could be designed and built within 10 years or so. Without the experience of building and operating such plants, estimates of the cost of the fuel they would produce are unreliable. And most such estimates, prepared by the technology's advocates, are too low. However, if synthetic fuels are to be available in significant amounts by the end of this century, pioneer commercial plants should be built today.

Despite the fact that public and political interest in synthetic fuels is at a low ebb, efforts are underway to establish such plants. Both the Department of Energy (DOE) and the government-funded Synthetic Fuels Corp. (SFC) are providing price and loan guarantees to help companies obtain private financing to set up plants. For example, the DOE is supporting the Union Oil Shale project in Colorado, which is scheduled to begin production within a year, as well as the Great Plains lignite-to-gas venture in North Dakota.

The SFC also signed four new contracts this summer—and may agree to as many as 12 more within a year—supporting a wide range of projects involving coal, peat, tar sands, and oil shale. The first of these, announced July 1, is the $300 million Cool Water Gasification Project in Daggett, Calif., which will convert coal to synthetic gas and then burn that gas to create electricity. The electric output will be equivalent to that available from 4,300 barrels of oil a day. SFC promises to cover up to $120 million of losses incurred by the plant, which is a joint venture of several utilities and electrical-equipment companies. The SFC has nearly $15 billion to use in this program, which, if successful, will provide a badly needed base of information from which to plan future synthetic-fuel ventures. □

John P. Longwell is Edwin R. Gilliland Professor of Chemical Engineering at M.I.T.

the underground sewage system that pushes wastes through pneumatic tubes at 60 miles per hour.

These behind-the-scenes innovations are much more interesting than the mundane gimmickry that Disney displays for the world to see. And they are much more compelling than the fancy architectural facades and foreign fast foods at the World Showcase. Unfortunately, Disney's obsession with secrecy prevents anyone from finding out just how "cutting edge" its techniques really are.

Sperry, in its "Astuter Computer Revue," comes closest to showing us Disney behind the scenes. The presentation stars Earlie the Pearlie, a cockney character straight out of Mary Poppins, in a ten-minute song-and-dance routine that extols the virtues of computers. The three-dimensional image of Earlie, which is projected into the room that houses all of EPCOT's computers, tells us that computers control almost everything at Disney World—hotel reservations, merchandise inventory, energy conservation, and the movements of Disney's famous audio-animated figures. But that's as far as Earlie goes. There is no mention of how these movements are synchronized with a sound track, how each audio-animated figure is automatically checked for mechanical failure, or even how the image of Earlie himself is concocted. When someone at a private briefing for M.I.T. alumni asked how that illusion was created, the response was: "Sorry, but that's a closely guarded secret. We're under contract from Disney not to tell."

Disney's innovations with fiber optics, transportation, and other technologies are also not for public consumption. "That is proprietary information," Doergis explained. "We have to make a profit, you know." The only research results from EPCOT that will be published are those from experiments run jointly with the government (such as the agricultural technology).

Throughout EPCOT, Disney seems to be saying: common people don't really want to know how we do it, so let's just keep them ignorant and pretend it's make-believe. That attitude is fine for Disney World, which is pure fantasy and great entertainment besides. But it makes a mockery of EPCOT, which, in Disney's own words, is supposed to be "a unique blend of showmanship and information." ☐

ALISON BASS is a senior editor of Technology Review.

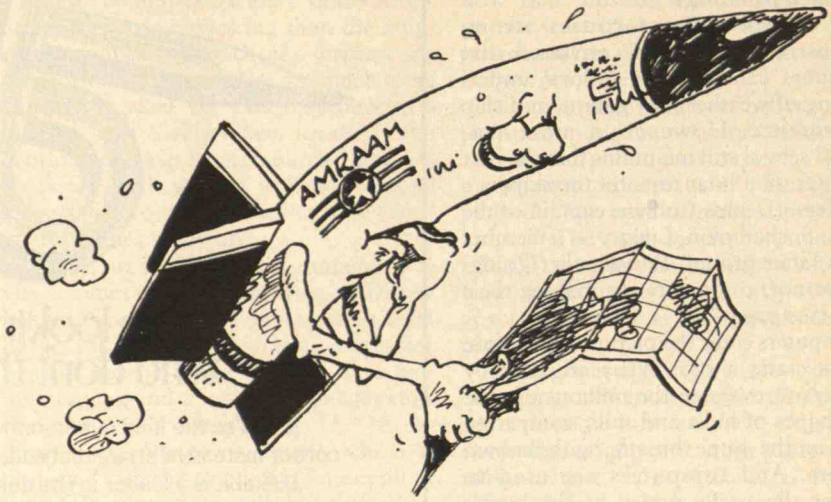
Continued from page 71
other electronic gear rouses strong passions. One school is convinced that computers can enhance sailors' understanding of weather, navigation, and ship performance. However, a more traditional school still maintains that the best computer on a boat rests on the skipper's shoulders. (Dennis Conner, captain of the 1980 U.S. champion, *Liberty*, is a member of this latter group.) But whether grudgingly or not, computers are making their mark. (*See page 70.*)

Computers enter the picture long before a yacht starts a race. They are used by designers to evaluate the millions of possible shapes of hulls and sails, comparing them, in the same breath, with known winners. And computers are used to monitor the performance of the boats, crews, and sails during the many months of preparation. The syndicates vying for this year's Cup went about this "tuning" in various ways. The American, Canadian, French, and two Australian boats had computers on board that stored data for later analysis. The British boat and *Australia II* sent data to minicomputers on board motorized tenders that followed the yachts as they trained. There an analyst could watch how the boat's crew, sails, masts, or anything else was performing as compared with other trials. The Italian boat—the first ever from that nation—sent data directly to a computer ashore.

During a race, the skipper and crew members can use on-board computers for navigation or strategy. For example, at the push of a button, the computer can indicate the course to steer to get to the next mark as fast as possible. If the skipper believes he can get there before the other boat without continuing the maneuvering duels that are endemic to match racing, he can cut and run. Or when approaching a mark, the skipper can calculate with considerable precision what the wind direction and speed will be when the boat comes about; thus he can tell the crew which sails to have ready.

Navigational computer systems are already making inroads into the realm of recreational sailing. For example, a recent advertisement in *Sail* magazine touts an electronic satellite-navigation system with "more than 40 different functions, including the industry's first route planning capability." A host of other electronic instruments, many of them first tested in the 12-meter yachts competing for the America's Cup, are also now coming onto the market. □

Is AMRAAM Missile Worth the Cost?



For more than a decade, the Soviet Union has been outproducing the United States by more than two to one in almost all conventional weapons, according to William Perry, former undersecretary of defense. The talley for fighter planes has been even more lopsided—four to one in recent years. The philosophy at the Pentagon, therefore, is to compensate for numerical inferiority with technological superiority, and the Advanced Medium-Range-Air-to-Air Missile (AMRAAM) is the latest example of this strategy. As proposed, neither weather nor cover of night could stop this radar-guided missile. AMRAAM's projected long range of 25 to 30 miles is designed to allow pilots to avoid "dogfights".

But AMRAAM's success depends on several unproven technologies, according to critics. Its long-range guidance system also depends on aircraft-to-missile communications that may be extremely difficult to maintain in combat. And to make matters worse, simulation tests have indicated that AMRAAM's long-range capability may not even be needed in combat. In short, critics, who include defense consultants for the Heritage Foundation and a former missile engineer for the air force, fear the United States is about to spend billions of dollars on a missile that would have no practical advantages over the Sidewinder, a short-range missile that costs one-tenth as much.

There is nothing mysterious about these "smart" missiles. They sense contrasts between target and background using radar, a heat-seeker, or a television sensor. Once the sensor is "locked on" the target, the missile adjusts its direction according to the angle between the sensor and the missile axis. Picking the right sensor is a matter of choosing one that will consistently find the greatest contrast between target and surroundings, and that will resist jamming.

Heat-seekers would seem to be the sensor of choice in air-to-air combat, where the hottest thing around is the tailpipe of another plane. The heat-seeking Sidewinder has a good track record, particularly in Vietnam. But heat-seekers have limitations. Clouds and humidity block the heat rays, and the maximum range is about ten miles even in ideal weather.

Radar can travel long distances through night and bad weather. So far however, the U.S. air-to-air radar missile, Sparrow, has proven unsuccessful. During the 1973 Israeli war, Sparrows scored none of Israel's 353 kills, according to Israeli General Mordecai Hod. In Vietnam, "it took 100 radar missile firing attempts . . . for 8 targets actually brought down," according to defense consultant George Kuhn, writing in the Heritage Foundation's "Agenda '83" report. He explained, "Radar missiles are far more complex technically than guns or [heat-seeking] missiles, and are therefore inherently less reliable. They are also more susceptible to tactical and other counter measures than infrared [or heat-seeking] missiles or guns."

The Sparrow's "semi-active" radar also makes it hard to use in combat. Instead of sending its own radar signals, the Sparrow homes in on signals the attacking pilot bounces off the target plane. This forces the pilot to limit maneuvers for 20 seconds or more to keep the target within range of the radar, according to Barry Watts, a former fighter pilot. This is a long time in an environment where only a pilot who "adapts to the more indistinct, more irregular and quicker changes of pattern and rhythm survives," according to John Boyd, another former fighter pilot in Korea. By contrast, the Sidewinder homes in by itself.

AMRAAM is designed to combine Sparrow's long range with Sidewinder's "fire-and-forget" capability. It's supposed to work like this: The pilot locks his radar onto the target plane. A computer connected to the radar estimates the position and trajectory of the target and tells AMRAAM's computer where to find it. The pilot then fires. The pilot's guidance system sends AMRAAM updates on target position until the missile is close enough for its own radar to take over. (AMRAAM has true self-guidance only at shorter ranges than Sidewinder—less than 5 to 10 miles.) However, if the pilot has to maneuver a great deal, there is a danger that his radar will lose track of the AMRAAM and the target, according to a missile engineer with 25 years experience in weapons testing and design for the air force and navy. Now working as a defense consultant, this source asked *Technology Review* not to use his name.

This long-range firing system also depends on several inadequate technologies, according to the missile engineer. To begin with, the philosophical centerpiece of AMRAAM—its ability to take on several enemies at once to compensate for numerical inferiority—depends on "Track while Scan." TwS is a computer system that, in theory, allows the aircraft's

ILLUSTRATION: JON MCINTOSH

radar to keep track of many target planes so the pilot can shoot down several at once. Instead of locking onto a single plane, TwS continuously scans the sky, sorting as many as hundreds of radar blips into well-defined tracks. From these, it estimates the speed and trajectory of each plane, and determines where to find it during the next scanning cycle. However, air-to-air combat is often too chaotic for a computer to follow. "As the situation [in air-to-air combat] gets more complex and more fluid," says Russell Murray, former assistant defense secretary for program analysis and evaluation, "it becomes more and more difficult for the TwS to keep track of target planes." Yet without TwS, AMRAAM may have only a marginal advantage over the much less costly Sparrow, according to Murray.

Neither AMRAAM nor Sparrow can be fired at long range without another poorly developed technology, "Identification, Friend or Foe" (IFF). The need for IFF was dramatized early in the Vietnam War, when some U.S. pilots equipped with Sparrows shot down blips on the radar that turned out to be friends. One IFF technology, a coded transmitter, "asks" each radar blip "who are you?" and waits for a properly coded reply, like a password. One danger with this technology is that the enemy will decipher the password. Another is that the transmitter will fail without the pilot's knowledge, endangering friendly aircraft. But the biggest problem is that the coded question will give our pilots away, according to the missile engineer.

A second IFF technology involves analyzing the echoes of different planes to determine which blips are enemy aircraft. Even though this method works 60 to 90 percent of the time, it is useless in practice, because pilots cannot risk shooting down their friends.

In the Selected Acquisition Report to Congress, the air force estimated AMRAAM's program cost at more than $500,000 per missile, with a total commitment of more than $8 billion (in 1983 dollars). In the last three years alone, Congress has allocated $343 million for research and development on AMRAAM.

In any discussion of price, it is important to realize that the guided missile is basically a technological kamakazi in a battle of economic trade-offs. Every time a pilot fires an AMRAAM, half a million dollars' worth of computer and radar equipment will go up in smoke in the hope of knocking out millions of dollars worth of enemy aircraft. But this trade-off makes sense only if AMRAAM hits its target and does so in situations where the $60,000 Sidewinder or the $350-per-shot aerial cannon would have been useless. Yet because of its technological flaws, AMRAAM does not appear to have any great advantage over the short-range Sidewinder.

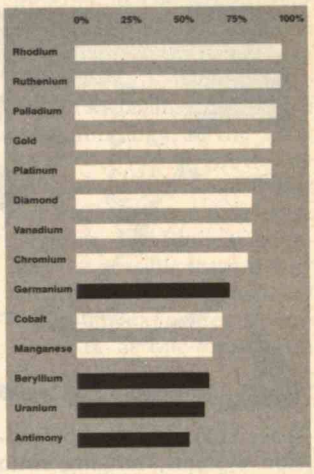
Even officials connected with the AMRAAM program seem to lack confidence in its long-range capability. In an off-the-record interview, an air force colonel actually denied that AMRAAM was built to be long range. "We built AMRAAM to be quick and fast," he said. "We just happened to get the range along with the speed."

Critics have also suggested that long-range firing is not very important in air-to-air combat. "Kills of unsuspecting targets at long range do not constitute the heart of air combat in an intense combat environment," according to Kuhn in the Heritage Foundation report. Furthermore, opposing air forces almost never line up on opposite sides of a perceived boundary within missile range. Indeed, "swarm warfare" would probably prevail in a European war, as it did in the Lebanese invasion, where 60 Israeli fighters engaged 90 Syrians. Under these conditions, pilots would have to fire at short range and identify friend and foe by sight.

Even simulation tests conducted by the air force have indicated that AMRAAM's long-range capability would probably not be needed in combat. During the test, pilots sat in simulated cockpits, each under his own TV-projected sky. Computers translated each pilot's maneuvers into projections on every other pilot's screen. The simulated IFF and radar worked perfectly, allowing pilots to see and identify enemy planes. At the same time, the TV-projected sky made it more difficult for pilots to eyeball the target, because the visual cues were poor compared with cues in the real sky. Both of these conditions should encourage long-range firing, yet the pilots ended up firing AMRAAM at less than five miles half the time.

These test results provoked "discussion within the Defense Department as to whether more range capability is being bought than is needed," according to *Aviation Week*. Kuhn, meanwhile, concluded that radar missiles, including the Sparrow and the AMRAAM, "will certainly not achieve the high attrition rate our planners project are necessary to overcome the Soviet quantitative edge."—*David Holzman* □

High percentages of many strategic materials are produced by the Soviet Union and a few African nations. The materials shown in white could be mined from asteroids in as little as 15 years.



Platinum from Space

Almost all meteorites contain higher concentrations of platinum, palladium, iridium, and other precious metals than any earthbound ore. And though meteorites may fall from the sky, that isn't where they originate. They're thought to come from asteroids that approach close to earth's orbit. These space-born motherlodes can be mined profitably, according to John S. Lewis, a planetary scientist at the Lunar and Planetary Laboratory at the University of Arizona. And the Solar System Exploration Committee, assembled by NASA, agrees that mining asteroids may well prove "economically important."

Anyone familiar with past asteroid-mining schemes may be skeptical: what are a few tens of billions of dollars for such a project, especially if Uncle Sam foots the bill? Proponents of plans to harvest extraterrestrial resources always seem to envision astronauts setting up shop in everything from asteroidal quonset huts to mile-diameter

DIAGRAM: OMNIGRAPHICS

space colonies. New propulsion systems, ranging from miles-long mass drivers to miles-wide solar sails, are advocated to bring gigantic asteroids into Earth orbit.

But as the Apollo era's flood of bucks fades into history along with other sixties memorabilia, space researchers are becoming increasingly wary about big-ticket items, and asteroid mining is no exception. Therefore, University of Arizona scientists have drawn up a bargain scenario:

☐ Only those asteroids that pass close to earth and are easier to reach than the moon will be mined. Astronomers have already chosen some two dozen such bodies. Later this year the University of Arizona Spacewatch telescope, dedicated to the search for near-Earth asteroids, will come into full use. The catalog of nearby asteroids that can be mined for platinum may reach the hundreds.

☐ Plans are to extract a few tons of ore at a time, using automatic mining equipment—no astronauts—and existing vehicles such as the upper stages of the space shuttle. The mining vehicle would bring the ore into Earth orbit. The cost of this transportation is difficult to predict, but it would require only 1 percent of the fuel needed to launch an equal mass of ore from the Kennedy Space Center.

☐ Once in Earth orbit, the ore would be refined by automatic equipment through the "gaseous-carbonyl process," which has been used on an industrial scale since the turn of the century. With a grant from NASA, Arizona's John Lewis is building a space-oriented version of the refining equipment.

In the carbonyl process, the crushed ore will be reacted with carbon monoxide (CO), obtained by heating material from asteroids. The temperatures required—up to about 200° centigrade—can be achieved by solar heat. The unwanted metals in the ore will combine with CO to form gaseous carbonyl compounds. These gasses will be separated out, leaving only the precious metals. A rocket will return them to Earth, using about the same amount of fuel as required to bring the ore into orbit.

Lewis expects to test his refining device on a flight of the space shuttle within two or three years. He hopes to launch a prospecting mission by the end of the decade and possibly begin mining operations in 10 to 15 years.

According to Lewis, the precious metals produced from this process would be worth $10,000 per kilogram. "This would knock the bottom out of the Soviet and South African platinum monopoly," he chuckles as he sketches plans to drop one-ton lumps of precious metals from his space mines into the Southwestern U.S. desert. However, it will be two or three years before Lewis can give a solid estimate of the price tag for the mining operation. So far, the only limit he's willing to put on R&D costs is that they should be less than required for the shuttle—some $15 billion. If the cost approaches that, the mining scheme could be in trouble.

According to Bob Waldron, engineering specialist at Rockwell International, the company that built the shuttle, there is one major uncertainty in Lewis's analysis. The carbonyl process takes a long time to separate out metals, particularly in a relatively small plant such as could be sent to an asteroid. If recovering the precious metals takes too long, Waldron explains, interest costs on the investment could nullify the expected profit.

However, financing for the mining project does have its promising aspects. The needed equipment can be made merely by modifying existing devices such as the space shuttle and its manipulator arm. Uncle Sam probably won't have to foot the whole bill—the Spacewatch asteroid-survey project already receives one-third of its funding from private sources. And though it is keeping all particulars confidential, an offshore oil-drilling giant, Brown & Root, Inc., has its own embryonic asteroid-mining project underway.—*Carolyn Meinel* ☐

Video Radiation: Fears Out of Focus

Alarms have frequently been sounded about radiation hazards from video tubes. Early color televisions leaked x-rays, and despite ensuing regulations, a pervasive distrust remains. More recent concerns focus on video display tubes (VDTs) that provide readouts from computers. Specifically, there is fear that x-rays, microwaves, or other forms of radiation may be responsible for cataracts, abnormal pregnancies, and other health problems experienced by VDT operators.

For example, one year at the *Toronto Star*, 4 out of 7 infants born to women working on VDT screens had defects. At Sears, Roebuck and Co. in Dallas, 8 of 12 pregnant women working on VDTs had miscarriages or babies with defects. Some researchers such as Dr. Nancy Binkin at the U.S. Centers for Disease Control (CDC) in Atlanta believe that such isolated reports are no more common than one would statistically expect and do not suggest any radiation hazard from VDT screens. Others such as Robert Dematteo, occupational health and safety coordinator for the Ontario Public Service Employees Union, disagree.

Less severe health problems have also been associated with VDTs. A survey published by the National Institute for Occupational Safety and Health (NIOSH) in June 1981 found that more VDT users than nonusers

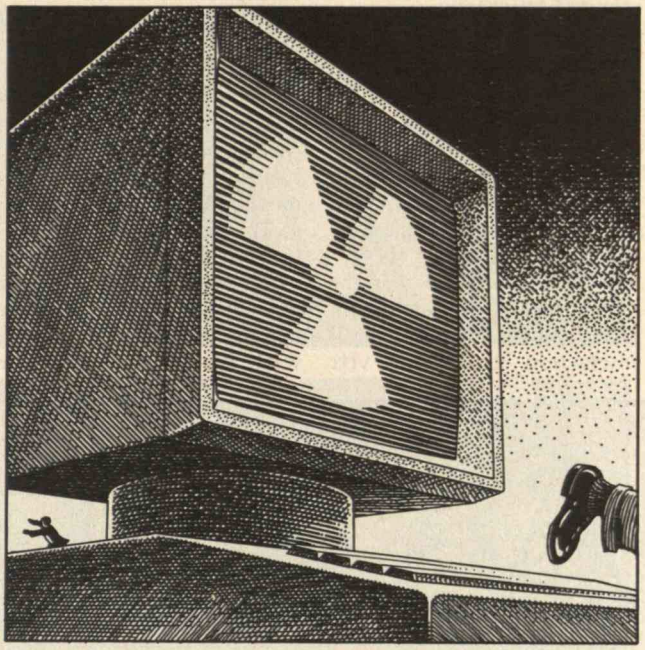
ILLUSTRATION: MICHAEL CRAWFORD

complained of numerous ailments. Some complaints might be related to physical demands of the machine: burning eyes (37 versus 16 percent), neck pain (37 versus 9 percent), and headaches (37 versus 13 percent). Other complaints suggest a more general state of tension: irritability (32 versus 9 percent) and difficulty sleeping (24 versus 13 percent). And some complaints are still harder to explain: frequent colds or sore throats (23 versus 9 percent), hay fever or sinus trouble (21 versus 9 percent), and skin rash (17 versus 6 percent).

Some of these problems may indeed result from little-understood effects of VDTs, including extremely-low-frequency radiation (*see "A new Radiation Hazard?" on page 82*) or even positive ions (*see "Negative Ions and Positive Vibes," January, page 74*). But an increasing body of research indicates that x-rays and microwaves from VDTs do not cause problems.

VDTs do produce x-rays. To make the video screen's image, electron beams are targeted onto a phosphorescent material; whenever a high-energy electron hits an atom, it can release x-rays. These, of course, may be harmful; federal regulations allow exposure to only 5 Rem (a standard measure of radiation) per year in workplaces and one-tenth that to the public. The maximum allowable radiation from VDTs is .0005 Rem per hour at about two inches from the screen.

To meet this limit, shielding is provided by the glass of the VDT screen itself. The glass is thick, with heavy elements added to provide a wide safety margin. If the glass does break, the video tube's vacuum is lost and it stops producing x-rays—indeed, it stops working altogether. Also, circuits cut off the VDT's power should the voltage begin to rise and produce more penetrating x-rays.



The federal government has made several exhaustive surveys of VDT installations for x-ray leakage, most notably in a series performed in 1981 and described in the Department of Health and Human Services publication "Potential Health Hazards of Video Display Terminals." I have also measured x-rays emitted from several hundred VDTs, both at the manufacturer and in offices. And neither mine nor any other survey has found more x-rays from the machines than federal regulations allow. Indeed, no survey has found more x-rays emitted from VDTs than are in background radiation in the environment.

Like x-rays, radiowaves and microwaves are electromagnetic radiation, but they have lower frequencies and less energy. Radio frequencies are generally considered to be waves of less than than 300 megahertz (million cycles per second). Microwaves have frequencies higher than this but less than 300,000 megahertz—the frequency that marks the beginning of the infrared band.

Microwaves and radio waves can heat animals just as infrared or visible light does. However, light heats the skin; radio waves and microwaves mainly heat the inside of the body, the principle behind microwave ovens. Heating from microwaves occurs at powers greater than roughly .1 watt per square centimeter. But other symptoms, such as anxiety and lassitude, have been ascribed to chronic exposures at much lower levels. The maximum exposure recommended by the American National Standards Institute, an industry-sponsored organization, is .01 watts per square centimeter.

However, questions about the safety of this level have been raised, notably in two articles by Paul Brodeur that appeared in *The New Yorker* in December 1976. Milton M. Zaret, an ophthalmologist practicing in Scarsdale, N.Y., and an associate professor of ophthalmology at the New York University-Bellevue Medical Center, has said that low-level radiation may cause cataracts. And Brodeur examined the possible reasons why the Soviet Union has set maximum exposures to microwaves at one-thousandth the U.S. level.

In 1977 a case brought by editors at the *New York Times* argued that two VDT users' cataracts were caused by microwaves, a charge that Zaret agreed with. However, the case was dismissed by an arbitrator, who reviewed NIOSH tests and the findings of a panel of medical consultants. The panel included doctors David G. Cogan from the National Eye Institute, Paul Henkind from the Albert Einstein School of Medicine, and Marvin Sears from Yale University.

Even if one agrees that low levels of microwave radiation may be harmful, one need not worry about them from VDTs. William Lowe, head of the Division of Compliance of the U.S. Office of Radiological Health, says that VDTs are incapable of producing microwaves. And surveys done by several government and private groups—including the June 1981 NIOSH study and another conducted in 1979 by two Bell Laboratories researchers, M.M. Weiss and R.C. Peterson—found no detectable emissions of microwaves from VDTs.

The surveys did find low levels of radio waves with frequencies of less than 1 megahertz. The Bell Labs researchers measured a maximum radiation in this frequency range at an intensity of .04 volts per meter—

ILLUSTRATION: ROB SAUNDERS

comparable to that of waves already in the environment from radio and television.

The Health and Human Services study reported higher amounts of radio waves in the range from 10 to 125 kilohertz—65 volts per meter two inches from the screen, falling off to 2.4 volts per meter at a foot. The present maximum exposure recommended by the American National Standards Institute for higher-frequency radio waves is equivalent to 200 volts per meter. No occupational standard has been set for radio waves in the lower frequencies measured in the NIOSH report, but it said that they "have not been shown to cause biological injury." Furthermore, the researchers concluded that the radio waves they found were partly caused by an electrical interaction between the VDT and the measuring instrument itself.

But until the evidence on other conceivable VDT safety hazards is clearer, a number of organizations recommend caution for users of equipment with video tubes. For example, NIOSH recommends a 15-minute rest break every other hour for VDT workers and a 15-minute break every hour for those with stressful work. The Labour Canada Task Force on Microelectronics and Employment recommends that pregnant women be allowed to do non-VDT jobs without penalty, that no operator work more than 5 hours a day on VDTs, and that rest breaks be provided hourly.—*James L. Jones* □

James L. Jones is a radiation-protection officer at M.I.T.

A New Radiation Hazard?

Extremely low frequency (ELF) radiation—electromagnetic waves comparable to light or radio waves but with far lower frequencies of only 50 to 100 cycles per second—may be created by any alternating current. Two sources of ELF radiation have recently been causing concern: high-voltage power lines and video display terminals (VDTs). The power lines carry current at voltages up to 1,000 times those in homes, so researchers have been able to study the effects of ELF emanating from them. The effects of ELF from VDTs are harder to study, since the voltages are similar to those of other appliances. However, operators often spend long periods of time close to VDTs and hence any adverse effects could be greater.

That ELF radiation can have biological effects is well known. Indeed, if carefully applied, ELF radiation may have medical benefits. In a long-standing medical procedure, devices producing relatively low amounts of ELF radiation are bandaged to the limbs of humans and race horses to speed up the healing of bone fractures. The worry arises over uncontrolled ELF radiation. Alan Grodzinsky, associate professor of electrical engineering and computer science at M.I.T., and Raphael Lee, a research scientist in the same department, are studying animals exposed to ELF radiation. They find that rats, mice, and miniature swine tend to avoid ELF fields. When the animals are in such a field, their activity and oxygen consumption increases and their nerve fibers conduct faster.

The symptoms observed in animals are temporary and not clearly bad. However, according to a hypothesis advanced by Dr. Robert O. Becker at the State University of New York Upstate Medical Center, ELF radiation may chronically stress the human body, lowering its resistance to disease and interfering with the immune system.

Part of the evidence for a chronic effect of this sort is epidemiological. In one large study, supported by the National Institute of Environmental Health Sciences and a number of U.S. agencies, Becker, F. Stephen Perry, and other researchers found a correlation between exposure to alternating electric fields—whether from power lines, household appliances, or other sources—and suicide. An evaluation of 438,000 deaths in the state of Washington by Samuel Milham, Jr., under the sponsorship of the National Institute of Occupational Safety and Health, found that electrical workers had a leukemia death rate 1.37 times the U.S. average. A smaller study in Los Angeles, by researchers at the Department of Family and Preventive Medicine of the University of Southern California School of Medicine, confirmed that same finding.

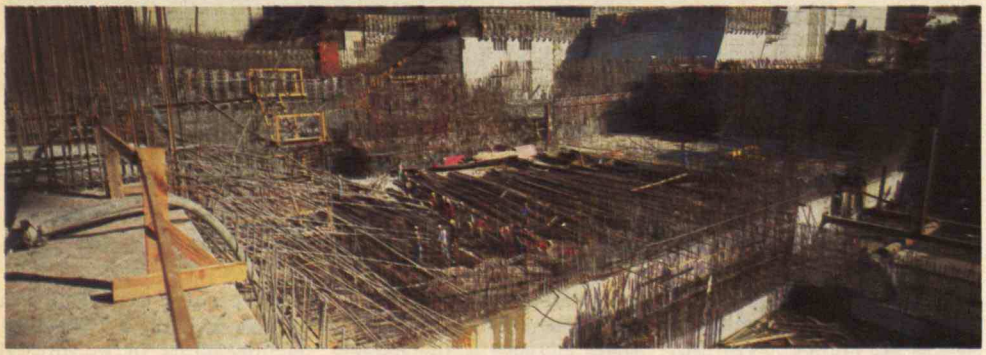
Some authorities dispute such concerns. For example, W. Harrison Mehn, a researcher associated with Northwestern University Medical School and the Commonwealth Edison Co., concludes that there is no known way ELF radiation associated with power transmission could affect animals.

The most obvious explanation for the effects of ELF radiation is that the electric field directly influences messages passed by the nerves, but this seems unlikely. Consider a power line carrying 20,000 volts that is 10 meters off the ground. The "voltage gradient" from the power line to the neutral earth is 20,000 volts over a distance of 10 meters, or 2,000 volts per meter. It is hard to see how this would affect a neuron, which has a much higher voltage gradient of some 10,000,000 volts per meter, though over a minute distance. Grodzinsky found that gradients of 100,000 volts per meter affected animals, and medical devices to help heal fractures work at .1 to .5 volts per meter. Indeed, some sensitive fish are affected by a mere .000001 volt per meter.

How ELF radiation causes its effects remains uncertain, and research is continuing on possible hazards. For example, the New York State Science Advisory Panel will oversee a five-year study of the possible hazards from high-voltage lines. But as far as VDTs are concerned, research suggests that any effects, if found, will be subtle and low-level.—*J. L. J.* □

ILLUSTRATION: DOUG SMITH

Now under construction, Brazil's Itaipu Dam is the largest hydroelectric project in the world. The dam's 18 massive turbine generators are expected to provide a capacity of 12,000 megawatts of electricity.



Macroengineering: Keeping the Dream Alive

The world is in economic and political doldrums—with a widening gap between "haves" and "have nots," rising expenditures on an unproductive arms race, vast Third World debts, and an increasing emphasis on conservation instead of consumption. These are problems enough to discourage the most optimistic builder.

For macroengineers it is a particularly bitter moment, with the world turning away from the very megaprojects that they believe could restore growth and prosperity.

Macroengineering is large-scale engineering—projects costing not less than $5 billion. Scores of such vast projects are now being undertaken, mostly in the Third World—including the Itaipu hydropower project in Brazil ($8 billion) and the vast Jubail ($50 billion) and Yanbu ($24 billion) industrial cities in Saudi Arabia. But unexploited macroengineering opportunities are everywhere—a sea-level Panama Canal, high-speed surface transport, lunar-based solar energy collectors, hydroelectric projects in the Himalayas, a great dam on the Congo River to create water resources for all of Central Africa. Advocates of macroengineering believe these projects, if begun today, would assure global prosperity tomorrow. The only problem is finding the money to get on with the job, says Ian K. MacGregor, chairman and chief executive officer of the British Steel Corp., a fiesty proponent of macroengineering.

A tunnel under the English Channel linking Britain and France, of which MacGregor is a principal advocate, has been put off for half a century through a combination of financial and political problems. And decreasing revenues have slowed to a near-standstill the OPEC nations' ambitious development plans, which include large petrochemical and refining plants, new water systems supplied by desalination plants, new transport networks, and all the modern infrastructure that symbolizes Western ways. Even in the United States, macroengineering projects to assure future energy independence have lost most of their momentum.

Macroengineering projects are not simply engineering carried to a few sizes larger: engineering and macroengineering are as different as day and night. Macroengineering almost by definition causes major environmental change. Big projects can also be major factors in international politics and finance. A failed project can drag not only its sponsors and investors but perhaps whole nations into bankruptcy. Special management talents and strategies are required, such as partnerships of financiers, engineers, and constructors. Frank Davidson, who heads the macroengineering research project at M.I.T. and is the author of *Macro: Neo-Industrializing America and the World*, which is due out late this fall, puts it this way: "Macroengineering investments preclude alternative investments. They imply basic choices among competing systems and values. Once in place, they are apt to last a very long time."

These special qualities have attracted the attention of engineering policymakers and managers for a decade or more. Now a consortium of builders, lawyers, financiers, and academicians who share this passion have formed the American Society for Macroengineering. Launching their new fellowship with modest fanfare in Boston last spring, these advocates proposed that their work represents the best investment in the future that the present can make. As people increase in numbers and expectations, more and more of the world's work must be done on gigantic scale. Projects must be costly, complex, time-consuming, and innovative in terms of financing and management as well as engineering, said Cordell W. Hull,

PHOTOS: CLAUS MEYER, BLACK STAR

vice-president of Bechtel Group, Inc., the society's first president. Thus, there is an urgent need to better understand these ambitious efforts so that they can be planned with future generations in mind and managed more efficiently than in the past.

To help underwrite macroengineering projects, Masaki Nakajima, former chairman of Mitsubishi Research Institute, Inc., advocates establishing a $500 billion "global infrastructure fund" on the model of the World Bank. Nakajima, who was the official delegate of Japan's macroengineering group to the U.S. society's ceremonies, says such a fund would be dedicated to shaping "a new global society."

According to Professor Jay W. Forrester of M.I.T.'s Sloan School of Management, however, Nakajima and his American friends must be patient. Forrester was himself a principal macroengineering architect in the 1950s; he helped design the Sage Arctic air warning system to protect North America from surprise Soviet attack. Now Forrester, using an elaborate computer-based model of the U.S. economy, believes he can identify a 50-year cycle of rising and falling capital investment and development. The rising part of this cycle, known as the Kondratieff cycle after the Russian economist who first proposed it, is now forecast for the 1990s. Forrester sees that decade as a time when we will cast into concrete and steel major decisions about energy, housing, transportation—our basic lifestyle—of the twenty-first century. Only then, Forrester predicts, will we be ready to make the macroinvestments that macroengineering requires.—*John Mattill* □

Upward Mobility on Two Wheels

Between 1900 and 1975, while planes, cars and trains occupied the center stage of technological change, the humble bicycle remained essentially unchanged. A visitor from Victorian times would find few surprises on one of today's ten-speeds. But even without major improvements, bicycles remain the cleanest and most efficient vehicles available for short-distance transportation.

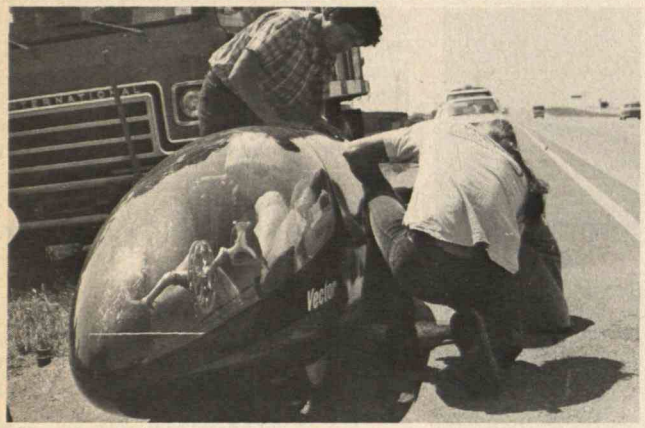
With the energy crisis in the early 1970s, the use of bicycles for commuting and everyday errands skyrocketed; the number of bicycles in use in the United States rose from about 20 million in 1960 to over 75 million by 1975. And with this new interest has come a new thrust of innovation—changes in bicycle structure for improved speed and safety, components and accessories designed to reduce drag, high-performance airless tires that last for ten years, and brakes that work better in wet weather.

The most radical of all these changes is the recumbent bicycle that puts the rider in a reclining position. The idea is not new—the earliest known example dates from 1895. But most early attempts to introduce recumbent designs met with derision or were simply ignored. A crucial exception occurred in France in the 1930s, when a relatively unknown racer, Francis Faure, riding a recumbent defeated the world champion in a four-kilometer pursuit race. The response of the International Cycling Union was to declare that Faure's machine was not a bicycle, thereby disqualifying Faure as winner. Vehicles differing from standard bicycles were disallowed from all further competition, and bicycle designers restricted their attention to conventional forms.

A very different view was taken by the International Human Powered Vehicle Association (IHPVA) when it was formed in 1975 to support greater creativity in bicycle design. The only entry requirements in its annual races are that the vehicles be exclusively human-powered and use no form of energy storage. The first IHPVA winner in 1975 was a conventional tandem ten-speed equipped with a fairing—a streamlined shell that completely encloses the vehicle with a transparent cockpit for visibility—that averaged 44.9 miles an hour in a 200-meter sprint. However, streamlined recumbents have won every IHPVA race since, with multiperson vehicles reaching speeds as high as 62 miles per hour. A recumbent won last year's race for single-rider vehicles at 51.9 miles an hour —25 percent faster than ever recorded on a standard bicycle.

On a recumbent bicycle, the rider sits back with legs out in front. By virtue of the rider's low position, the air resistence, or drag, is about 20 percent less than that of a conventional bicycle, according to Chester Kyle, professor

This tandem tricycle, enclosed in a streamlined shell, looks out of place on the freeway, but it traveled 42 miles along Interstate 5 in California at an average speed of 50.5 miles per hour. While there was no net change in altitude along the route, the riders climbed and descended one to two percent grades.



of mechanical engineering at California State University at Long Beach. When equipped with a fairing, the recumbent design can reduce drag by more than 50 percent. Since drag is responsible for over 80 percent of the friction that slows bicycles down—the rest being due to the friction of the tires on the road and in the bicycle mechanism itself—these reductions account for the speed advantage. Some recumbent proponents claim that the design also allows the rider to generate more leg power, but tests have been inconclusive.

For bicyclists more interested in improved comfort and safety than in speed, the recumbent also offers dramatic advantages. On a traditional bicycle, the rider's weight rests on a hard, narrow seat; recumbents usually feature comfortable chairlike seats. On a recumbent the rider's center of gravity is lower and farther back than on a standard bicycle, making for great stability and safety. In accidents, riders of conventional bikes often find themselves flying head first over the handlebars; on a recumbent, riders usually slide off feet first, according to David Gordon Wilson, professor of mechanical engineering at MIT. Recumbent proponents do acknowledge one safety disadvantage. Because of the low profile of the recumbent, says Kyle, "you can't see or be seen as well" as when you're riding a conventional bike.

Until recently, recumbent proponents have found themselves mostly talking to one another. The few small companies producing recumbent bicycles think they are doing well to sell a few hundred a year. But larger companies are showing interest. "I think there's a need building out there for more efficient bicycles," says Jay Townley, vice-president of Schwinn. "You've got to look at recumbents." Schwinn hopes to introduce one in 1984. Gardner Martin, developer of the Easy Racer recumbent bicycle, thinks that within ten years, "half the adult market will have switched to the recumbent." Already the recumbent has invaded the heart of the U.S. transportation network: in 1980, the Vector, a recumbent tricycle, surprised drivers along 42 miles of Interstate 5 in California, maintaining an average speed of 50.5 miles per hour.

While few people may want to take their recumbents onto the interstates, Martin and other bicycle designers are dreaming of a quieter, cleaner world full of people using their bicycles to meet their short-distance transportation needs. However, as long as gasoline is available and affordable, a massive switch to human power seems unlikely. "It's so much easier to get in a car and turn on the ignition," notes Charles Champlain, current president of the IHPVA.

Even if recumbent bicycles don't soon flood the streets, many smaller innovations now available for use with standard bicycles offer some improvement in speed, safety, and comfort. For example, Shimano Corp. of Japan has introduced a full line of components designed to reduce drag, including streamlined brakes, pedals, and cranks. These components cut wind resistance of the bicycle by 20.6 percent by reducing the turbulence of air flowing past the bicycle. When the drag of the rider is taken into account, overall drag is reduced about 5 percent. Bicycles featuring both streamlined frames and components can cut drag by as much as 10 percent.

High cost currently makes such aerodynamic bicycles practical only in racing, but the streamlined full fairings used in IHPVA races may eventually be adapted for general use, making the bicycle an all-weather vehicle and providing additional crash protection. Meanwhile, Zzip Designs of Santa Cruz produces partial fairings for conventional ten-speed bicycles. These small plastic shields attach to the handlebars and cut overall drag by 22 percent, yielding about a 7 percent increase in speed. Furthermore, the fairing provides the rider with some protection from cold and wet weather. The fairing, which costs about $55, is nearly unbreakable and seems to offer a little extra protection in accidents, according to Glenn Brown, founder of Zzip Designs.

Other innovations abound. Deal Drive International of England now offers an automatic 16-speed transmission. However, it weighs 3.5 pounds, a significant penalty. Shimano is introducing a computer-designed drive system featuring gears shaped like parallelograms with rounded edges, which allow a more natural and powerful leg movement. Airless tires of solid polyurethene made by Zeus Manufacturing of Irvine, Calif., are lightweight and perform well. Zeus claims the tires have low rolling resistance, improved traction, and no blowouts, a major cause of bicycle accidents.

Unfortunately, bicycle manufacturers hesitate to step away from conventional designs, and many promising inventions never make it past the prototype. One such victim is a new brake developed by Wilson and graduate student Brian Hanson at M.I.T. that sharply reduces stopping distances in wet weather. A rider with the new brake can stop from 15 miles per hour in about 12 feet, instead of the 50 feet typical of most bicycle brakes. However, federal standards regulate only dry braking distances on bicycles, and no company has expressed interest in manufacturing the system. "You come up with things that you think are pretty good," says Wilson, "but you can't get anyone to move on them."

However, bicycle innovators are undeterred. As Kyle sees it, "It's just as in any other scientific endeavor; you feel you're working toward the future."—*Frank Lowenstein* □

PHOTOS: RICH TURNER AND CALTRANS

New Managers for New Styles

Some of the old assumptions about people and their jobs are outmoded, says Professor Lotte Bailyn of the Sloan School of Management—that men work and their wives raise the family, that work is a total commitment for those who engage in it, that anyone who is any good wants to move up.

There are lots of exceptions in the American workforce to such traditional viewpoints. But many managers still assume that "what is true for them is true for all." Professor Bailyn's solution is patience: "We have to wait for a new generation to manage our organizations and for new procedures to emerge in response to the needs of 'nontraditional' employees."

But a word of warning: it will be easy, under those new conditions, to overreact to the new trend. The real problem, says Professor Bailyn, is the underlying assumption of homogeneity—that all workers are alike, and that their interests are unchanging through various stages in their lives. □

The Costly High Cost of Capital

The cost of money is higher in the United States than in most countries with which we compete, and our low rate of productivity growth and unfavorable trade balance during the last quarter-century are a direct result, says George N. Hatsopoulos, senior lecturer in mechanical engineering at M.I.T. who is chairman and chief executive officer of Thermo Electron Corp. in Waltham, Mass.

The difference is especially sharp between the U.S. and Japan—an "enormous gap," says Dr. Hatsopoulos in a report sponsored by the American Business Conference, Inc., of which he is a founding member.

From 1961 to 1973, the cost of capital—interest and related expenses—was about 15 percent a year, adjusted for inflation, in the U.S. But then it rose sharply to about 20 percent, where it remains.

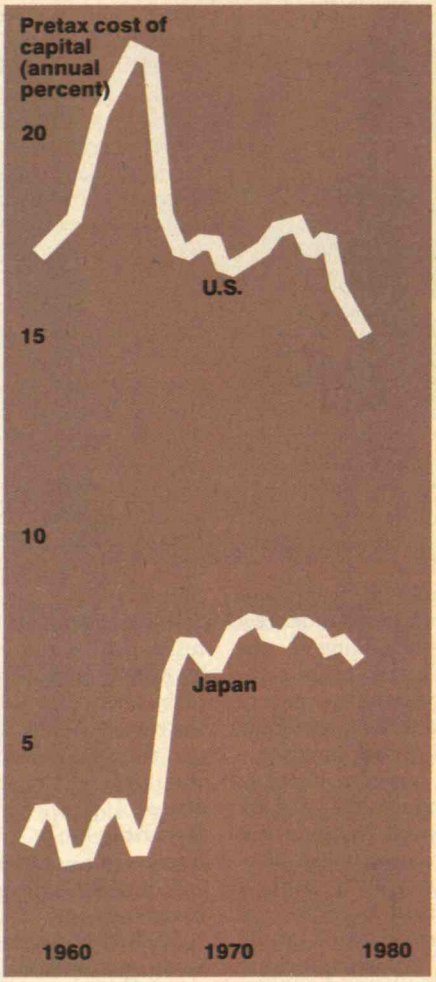
Two related factors make this high cost especially serious:

□ The cost of capital has increased 20 percent more than the cost of labor since 1973. "As capital becomes more costly relative to labor," Dr. Hatsopoulos explains, "firms tend to forego investments needed to boost labor productivity."

□ There has been no increase in corporate productivity to compensate for the rise in the cost of capital. The result is that capital formation has been weakened and economic growth slowed.

Japanese entrepreneurs have always paid less for capital than those in the U.S.—about 7 percent compared with 15 percent a year in 1961. After 1973, while the cost of capital rose in the U.S., it fell in Japan. By 1981 the annual rate was 19 percent in the U.S. compared with 5 percent in Japan, where the low rate served to stimulate research and entrepreneurship and helped the Japanese keep costs down. Indeed, Dr. Hatsopoulos' analysis shows that the low cost of capital is just as important to the success of Japanese products on world markets as the low cost of labor. If a product that can be made for $10,000 in the U.S. can be made for $5,000 in Japan, the lower cost of capital accounts for $2,300 of that difference and the labor differential $2,800.

How to lower the cost of capital in the U.S.? Change tax policy by permitting corporations to make increased use of tax-favored sources of financing, says Dr. Hatsopoulos. For example, if dividends on preferred stock were treated as tax-deductible interest payments, corporations could issue stock in lieu of bank borrowing. Or let corporations issue debt instruments with the repayment rate tied to the corporation's profitability. □



Before 1973, the cost of capital was about twice as much in the U.S. as in Japan. Then came the Arab oil embargo, and the cost of capital went up sharply in the U.S.—while falling in Japan. The resulting differential goes far to explain the "enormous cost advantage enjoyed by Japanese companies relative to their U.S. competitors," says George N. Hatsopoulos in a new study by the American Business Conference, Inc.

Four Ways to Beat Japan

A four-point plan from Michael L. Dertouzos, director of the M.I.T. Laboratory for Computer Science, to maintain the U.S. lead in computer science in the face of strong competition from Japan's "fifth-generation computer project" (*see May/June, p. 78*):

□ A national effort funded at $100 million to $200 million a year to develop high-speed computers, as well as computers with artificial-intelligence functions. A plan for such an effort, to be led by the Defense Advanced Research Projects Agency with university and industrial involvement, is now being prepared for congressional approval.

□ An open policy toward foreign scholars working in U.S. universities, and vice-versa; and toward information flow between U.S. industries and overseas competitors. In both cases, Professor Dertouzos argued, proven advantages of free information exchange far outweigh the occasional damaging "leak" of proprietary information.

□ Tax credits for industrial sponsorship of research "that is very long range and in accord with the national priority."

□ Careful reexamination of antitrust pol-

DIAGRAM: OMNIGRAPHICS

icy to avoid inhibiting industrial consortia such as the new Microelectronic and Computer Technology Research Corp. (MCC) in support of long-term research and development.

A major concern, said Dertouzos speaking to a conference of nearly 500 business executives from 300 companies at M.I.T. during the summer: U.S. industry's traditional orientation to short-term gain at the expense of long-term R&D. "Short-run success . . . will not put us in a competitive situation with Japan," Dertouzos said. □

The Non-Nuclear Imperative

A new European Security Study (ESECS) concludes that "the pressing task for NATO is to improve deterrence against a Soviet attack by . . . finding ways to defeat a Warsaw Pact offensive with non-nuclear systems."

The problem is not in fact so difficult, says ESECS—simply adapt conventional, non-nuclear weapons for use on the guided missiles that have been developed to deliver nuclear weapons, and then develop new systems for surveying Warsaw Pact targets and guiding these highly sophisticated missiles to them.

Non-nuclear technologies have three advantages, says the ESECS report:

□ They have an appropriate combination "of timely availability, range, accuracy, and lethality."

□ The technology has been demonstrated and can be available soon.

□ The cost will be modest—some $10 to $30 billion.

Despite its enthusiasm for non-nuclear technology, ESECS warns that nuclear technology will still have a place in Europe, as a response "to the threat of a major loss of territory or imminent defeat in a land battle." But an improved non-nuclear defense would reduce the likelihood of these circumstances, the study says.

The European Security Study from which these recommendations come was organized in 1981 by the late Carroll L. Wilson, emeritus professor in the Sloan School of Management at M.I.T. Following Professor Wilson's death early this year, ESECS was completed under the leadership of Professor Robert R. Bowie, former director of the Center for International Affairs at Harvard. □

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